September 4, 1961

CHEMICAL ENGINEERING

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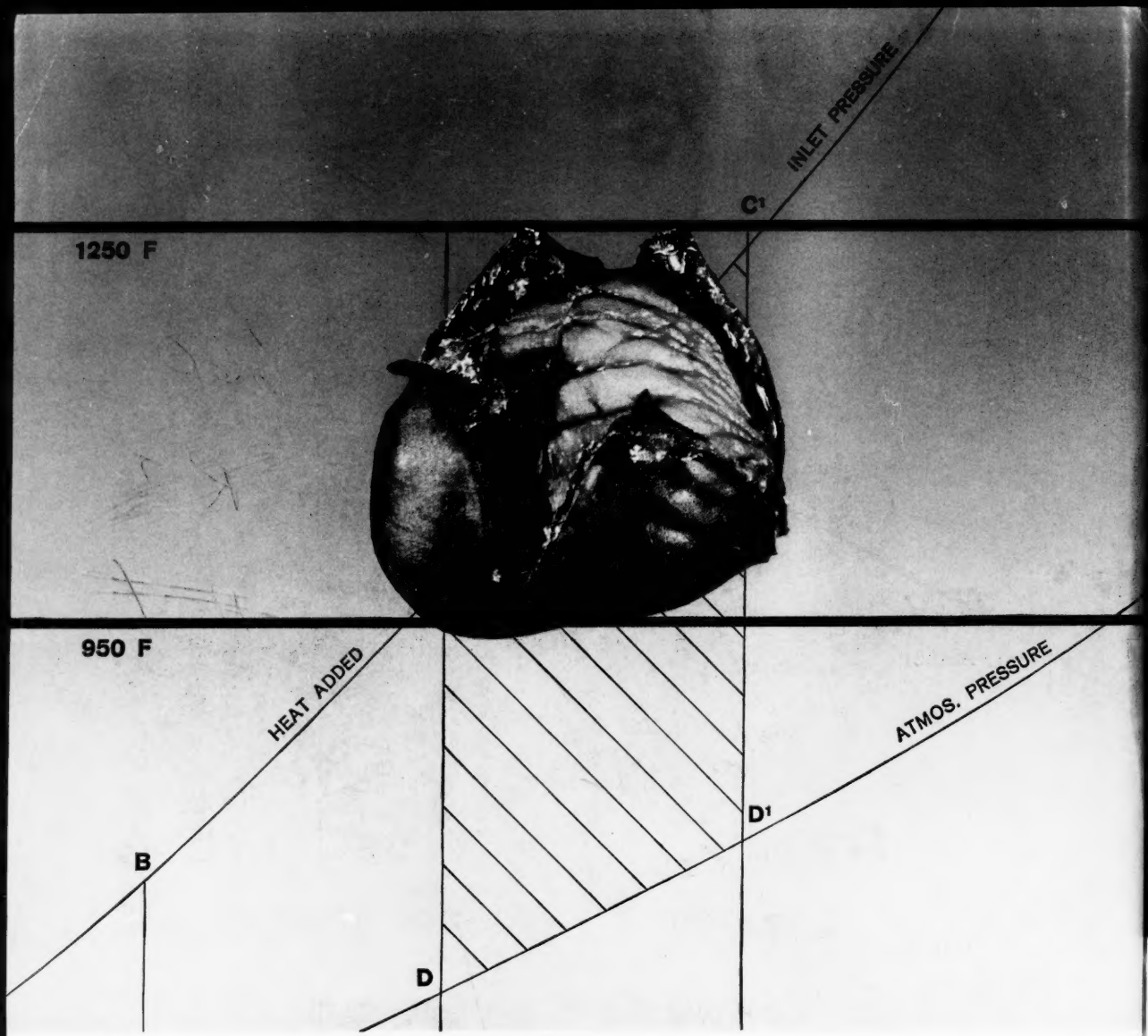
ETROCHEMICALS—
oday's Black-Gold Rush

page 3



THE POWER RECOVERY "CHESTNUT"

or how to take power from 950F—1250F tail gas

A proven method for taking mechanical power from process tail gas below 950F is the turbine. Taking power from tail gas above this temperature has, in the past, been a power recovery "chestnut"—too hot to handle despite its desirability. But now, Worthington offers a Power Recovery turbine that can successfully pluck the meat from this very hot "chestnut."

The "meat" is extremely tasty. Frequently, if tail gas can be put to work at 1250F instead of 950F, as much as 12 to 15 per cent more power can be captured. In some installations, the heat exchangers that formerly handled the drop to 950F can be eliminated. In others, thermodynamic analysis will now show the feasibility of heating the gas to 1250F to get maximum mechanical power recovery.

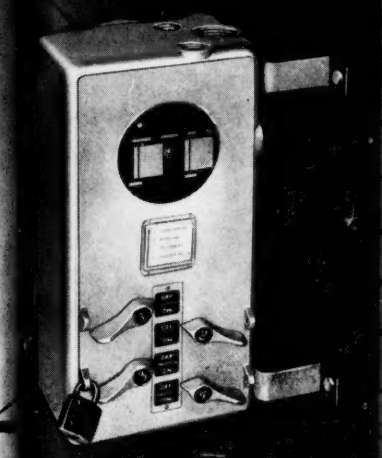
In the past, use of Power Recovery turbines at the higher temperatures has been impractical. One major problem has been in mechanical design. Misalignment caused by excessive thermal expansion, higher temperature sealing, rotor construction, and forces imposed on the expander by inlet piping expansion and construction are all part of the problem. Today, Worthington has minimized them by creating a new design and using new materials.

A second major problem area that Worthington has overcome is analysis of the gas itself. Most tail gases are mixtures and their behavior is not fully plotted at the temperatures involved. But the behavior must be known before the turbine can be designed. Today, Worthington is ready to analyze the heat recovery potential of any gas or gas-steam mixture and to design a Power Recovery turbine to match.

If you would like to taste the meat of this power recovery chestnut, above or below 950F, write or call Worthington Corporation, Turbine Division, Dept. 48-14, Wellsville, N.Y.

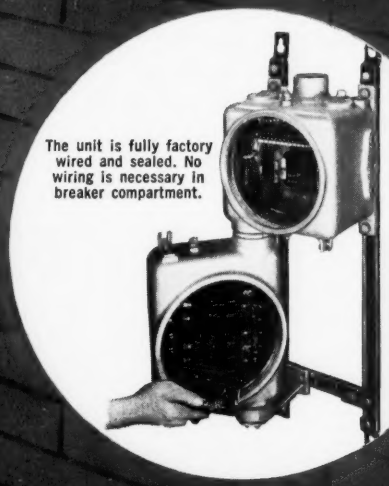
WORTHINGTON

PRODUCTS THAT WORK FOR YOUR PROFIT

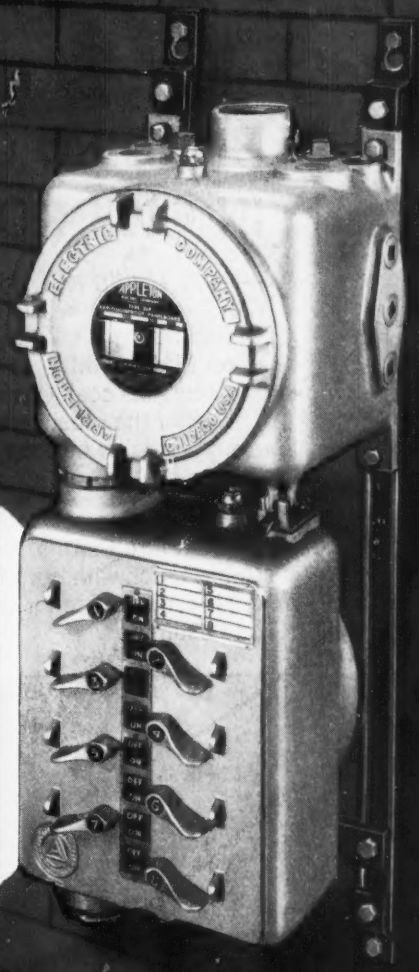


"NEW ESP" ECONOMY SERIES

NEW "EDP" WITH EXCLUSIVE APPLETON ENGINEERING FEATURES



The unit is fully factory wired and sealed. No wiring is necessary in breaker compartment.



NEW APPLETON®

EXPLOSION-PROOF PANELBOARDS

EDP represents an entirely new, distinctive engineering advance in panelboard design.

EDP features a unique exclusive PIVOT between junction and breaker housing. This is the *Key* to Compact Size, Plug-In "E" Frame Breakers, Easier, more Convenient Installation, Quicker Main and Branch Wiring and Simplified Maintenance.

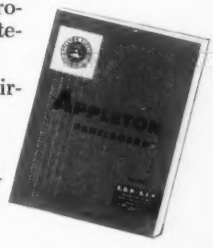
APPLETON EDP panelboards are engineered to handle motor control, machinery, alarm, lighting and a wide range of circuits requiring breaker capacities of 15, 20 or 30 amperes. They are available for 4 to 24 single pole, 2 to 12 double pole and 2 to 8 three pole circuits in various wiring systems.

Field wiring consists of connecting main and branch lines to pressure type terminals. Terminal boards are numbered for easy identification.

NEW ESP ECONOMY SERIES

ESP is compact, rugged, dependable and low cost. It embodies many unique features that provide easy installation, convenient maintenance, maximum safety and long life.

ESP is available for four single pole circuits, or two double pole circuits.



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APPLETON® *electric company*

1701 Wellington Avenue, Chicago 13, Illinois

CHEMICAL ENGINEERING

September 4, 1961

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

COVER PHOTO: Butadiene extraction unit at Humble Oil & Refining Co., Baton Rouge refinery. Photo courtesy of Enjay Chemical Co. Story on p. 113.

OTHER REGULAR FEATURES

WHAT'S HAPPENING

ENGINEERING PRACTICE

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VOLUME 68, NUMBER 18

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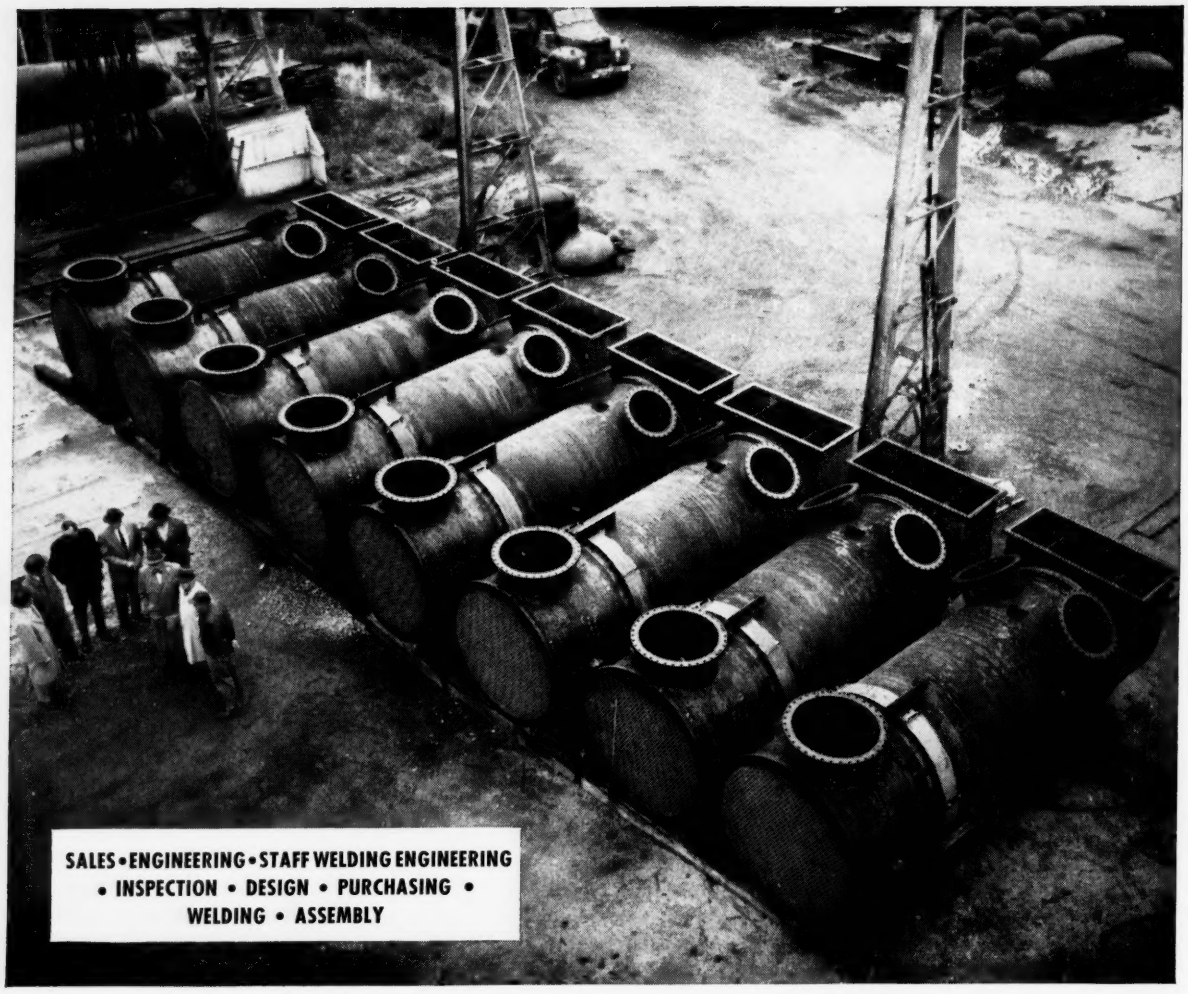


We're all on the quality control team at Downingtown Iron Works

Yes, when you place heat exchanger orders with Downingtown, every department of the company contributes to quality construction of the units you need. Every man makes quality control his business—whether he's in sales, engineering, design, purchasing, welding, assembly or inspection. Write for helpful bulletins on heat exchanger design.

UNIT SPECIFICATIONS

Here are specification details for one of the units pictured above:

Size:	72" diameter by 16'0" tube length
Tubes:	1406—1¼ O.D. x 12 BWG
Tube Material:	SA213 Grade T-12 (Chrome Moly Steel)
Tube Sheets:	2⅜" thick SA387 Gr. B Firebox Low Alloy Steel
	2¼" thick SA212 Gr. B Firebox Carbon Steel
Shell Material:	½" thick SA387 Gr. B Firebox Low Alloy Steel
	½" thick SA204 Gr. B Firebox Low Alloy Steel
	½" thick SA285 Gr. C Firebox Carbon Steel
Baffles:	½" thick Type 502 Stainless Steel
Expansion Joint:	6' diameter, triple corrugation, bellows type
Design Conditions:	14 psi @ 1000° Fahrenheit
Weight:	47,000 lb. each

All tubes are seal welded at both ends.

Downingtown Iron Works, Inc.

140 Wallace Ave., Downingtown, Pennsylvania
division of **PRESSED STEEL TANK COMPANY** Milwaukee
Branch offices in principal cities

HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

DOWNINGTOWN IRON WORKS INC.
Hackney

CHEMICAL ENGINEERING

highlights of this issue

PETROCHEMICALS: WHAT'S AHEAD?

No matter how you choose to define the word (see Editorial, p. 7), the petrochemical segment of the chemical industry is big business. Chemical engineers laid the foundations for this business some three decades ago, before the word itself was coined; indeed, growth of the chemical engineering profession has paralleled the rapid growth of petrochemicals.

This field is now in a state of flux, with shifting patterns in geography, technology and economics. Assistant Editor Labine—aided by Regional Editors Arnold and Robbins, McGraw-Hill reporters around the country and dozens of industry spokesmen—has put into perspective (p. 113) the various, often conflicting, influences at work in the dynamic petrochemical business.

PETROCHEMICALS: WHAT'S HAPPENING

Feature news stories in this issue emphasize the part played by petrochemicals on the current chemical scene. In petrochemical raw materials, we report what Conch International learned about transoceanic shipping of liquid methane (p. 64). In first-generation petrochemicals, our Process Flowsheet (p. 106) depicts Mobil Chemical's new ethylene unit at Beaumont. Two additional stories on petrochemical markets deal with the competitive situation in polystyrene (p. 68) and the prospects for cyanoethylation of cellulose with acrylonitrile (p. 62).

SIX QUICK WAYS STATISTICS CAN HELP YOU

"Almost any data, if pushed and pulled enough, can be made to support almost any conclusion," observes Du Pont's Bradford Brown (p. 137). Unless you're an expert statistician, you may hesitate to get involved in the laborious, high-powered mathematics of statistics. Here are six simple, easily applied techniques, based on nonparametric statistics, which anyone can use for rapid analysis of raw data.

Letters: Pro & Con

Flexible Paint Makers

Sir:

Your May 29 *Chementator* (p. 38) contained an item headed "Oil-based paints fight to retain markets via water solubility." The story states that makers of conventional oil-base paints, as well as suppliers of drying oils, are seeking to protect oil-base paints against inroads by synthetic latexes.

So far as most paint manufacturers are concerned, the statement is incorrect. Practically all makers of oil-base paints also offer synthetic water-emulsion paints. They have no vested interest in oil and do not give a rap which way the pendulum swings. Their sole concern is to give the customer whatever he prefers. The outcome will be decided by the user, with small regard to the opinions of oil producers and paint manufacturers.

WAYNE R. FULLER
Grand Rapids Varnish Corp.
Grand Rapids, Mich.

Dynamic Objectives Feedback

Sir:

Congratulations on your fine critique of the AIChE report on Dynamic Objectives (Mar. 20, pp. 166-170). I think you have reflected the questions which are in the minds of a great many members of the Institute. These questions have an important bearing on why the Institute membership includes only some one third of the total graduate chemical engineers.

NORMAN H. PARKER
Tower Iron Works
Providence, R. I.

Sir:

Your article was a thoughtful and provocative review of the Dynamic Objectives statement of the AIChE committee. The subject, broadly interpreted, has come to us before and is, in fact, with us now in the guise of several proposals.

F. PHILIPS PIKE
National Science Foundation
Washington, D. C.

Sir:

May I congratulate you on your fine article, "What Are the Dynamic Objectives?" The problems you outlined are being vigorously debated here.

As a senior in chemical engineering, I have been assigned by one of my professors the task of objectively evaluating our curriculum and have been instructed to propose changes which will more adequately meet the chemical engineering educational objectives. I'm especially interested in viewpoints which are in opposition to that of the AIChE report.

RONALD H. COWGILL
University of Colorado
Boulder, Colo.

Sir:

I happen to be a member of the Metallurgical Section of AIME, which has also disturbed me by lack of foresight in matters of professionalism. However, they are beginning to recognize the limitations of the technical society in the professional field.

Engineers must unify their professional activities or continue as a second-class profession in the public image. Let's stop duplication of effort.

ALFRED B. SABIN
Alfred B. Sabin & Associates
San Francisco, Calif.

Sir:

Your article probes gently into a region which I believe contains the wellsprings of the engineering profession's disunity.

There are a number of areas in which suppliers of engineering services and consumers of engineering services have a genuine conflict of interest. In most engineering societies no distinction is made between these suppliers and consumers in matters of membership and, most important, officership.

As a result, most engineers are moderately to actively dissatisfied with their technical societies. This is because the engineer is encouraged to look to the society for solution of pressing problems which it is organically incapable of solving; the technical society either pretends to consider itself the vehicle for satisfying all of the engineers' professional problems, or at least the society fails to disclaim such ability.

Engineers should recognize that this is an unsolvable problem and should afford the societies the support they deserve for their functions in non-conflict areas. I fear too many engineers are instead withholding their entire support, which is a very sad thing.

It was obvious to me that you perceived these awesome difficulties and used your criticism of the committee report to stimulate thinking in this direction without exciting any of the highly charged presensitized feelings that exist in this area. I hope your patience proves adequate to this task.

DAN N. HENDRICKS, JR.
Seattle Professional Engineering Employees Assn.
Seattle, Wash.

► *Messrs. Sabin and Hendricks both bring up the question of the proper role of the technical society in the professional field.*

Let's see how AIChE, for example, states its objects in its constitution: "the advancement of chemical engineering in theory and practice and the maintenance of a high professional standard among its members."

The key problem is: what do you mean by the word "professional"? Some engineers equate it to social and economic status. Should AIChE actively seek to enhance the social and economic status of its members? We think not.

Using our preferred definition of the term (see Editorial, July 24, p. 7), the true role of the technical society is to encourage among its members a high standard of competence and skill in the practice of their occupation (or profession). Social and economic status will follow, if and when they are deserved. —ED.

Your comments and opinions are important. Send them to Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y. They'll be welcomed.

What Do You Mean, "Petrochemical"?

Our major report (p. 113) on the future of petrochemicals focuses attention upon a word that has been both maligned and embraced, often by the same people. Despite its etymological illegitimacy, it is a serviceable word when properly defined and used.

To the purist, of course, a "petrochemical" is a chemical derived from or based upon stone or rock. Common usage, however, has established that petrochemicals are derived from petroleum or natural gas. But not everyone agrees on how broadly this definition can be applied. There is much confusion, especially in the reporting of statistical data.

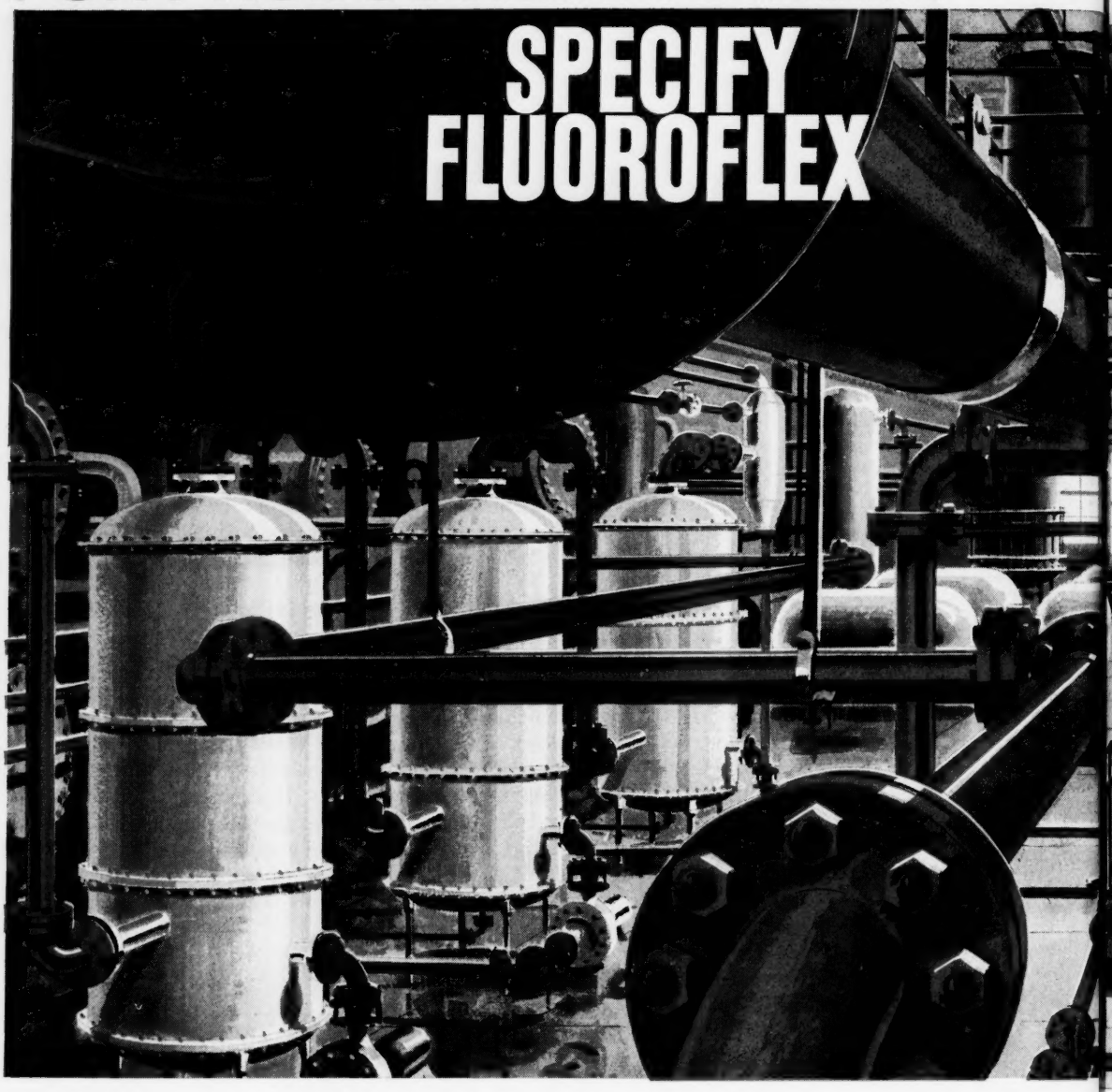
We submit that the term "petrochemical" as a *noun* is best reserved for first-generation chemical products derived from oil and gas. Acetylene produced by pyrolysis of natural gas is manifestly a petrochemical. But vinyl chloride made by reacting acetylene with hydrogen chloride is not, ipso facto, a petrochemical. Chemistry and technology of the latter process are independent of and unrelated to origin of the acetylene, as witness the fact that vinyl chloride was being made commercially from carbide-based acetylene long before acetylene from natural gas became commercial. Another factor is that the progeny of first-generation petrochemicals often derive much of their substance from non-petrochemical parents. In our vinyl chloride example, roughly 60% of its weight comes from HCl and only 40% from acetylene.

On the other hand, the term "petrochemical" may be broadly applied as an *adjective* to indicate an ancestry in petroleum or natural gas. Thus for statistical purposes, it may be desirable to identify as "petrochemical vinyl chloride" that portion of the total U. S. vinyl chloride production in a given year that traces its hydrocarbon content to oil or gas. This use of the term can be extended to define the petrochemical industry as the portion of the chemical industry that produces first-generation petrochemicals and chemical derivatives thereof.

In essence, the only distinctive characteristic of a petrochemical is its ancestry, and in the melting pot of modern chemical technology, family connections quickly fade away. The chemical engineering profession has been intimately involved in developing and producing synthetic organic chemicals since long before the word "petrochemical" was coined. And chemical engineers will continue to point the way to economical operations based on the relative costs of all available raw materials.

—Cecil H. Chilton

FOR PRODUCTION ECONOMY



TO STOP CORROSION, DOWNTIME, AND

The complete inertness of Fluoroflex*, Resistoflex's specially processed Teflon† construction material, is well known. The fact that Fluoroflex exhibits zero corrosion to all acids, chemicals, and solvents up to 500°F. (except free fluorine and alkali metals at elevated temperatures) is one reason for the completely successful and satisfactory use of Fluoroflex in hundreds of process plants both here and abroad.

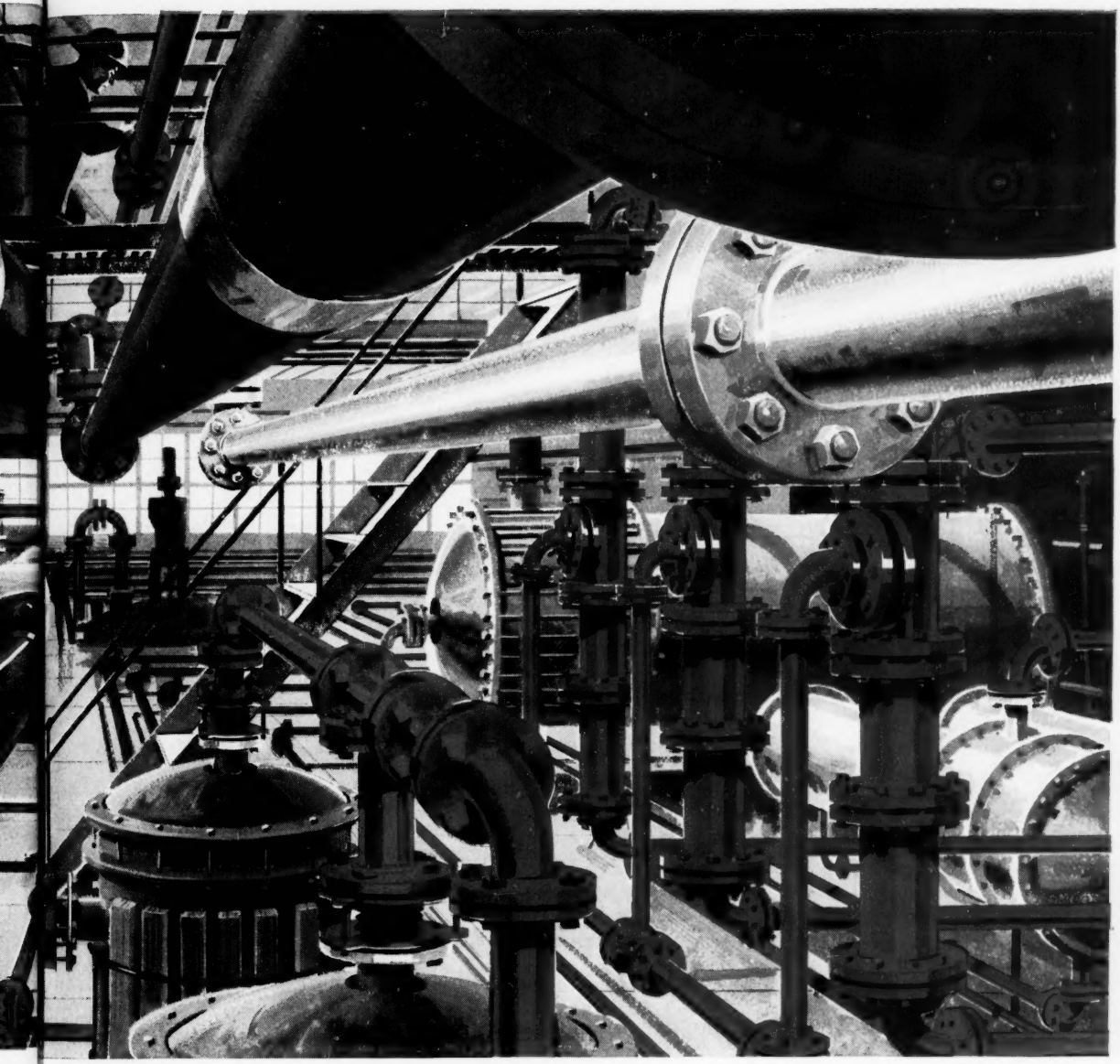
Because of this superior performance, one might expect a Fluoroflex system to be more expensive than it is. However, on an installed cost basis, Fluoroflex-lined steel piping is today comparable with or cheaper than pressure-piping of several high-nickel alloys.

As a result leading engineering-construction firms now use Fluoroflex rigid piping systems and flexible components in new plant construction to stop corrosion or contamination and to reduce erection costs.

Many small processing columns can be assembled from sections of Fluoroflex-lined pipe for rectifying, absorption, and scrubbing operations. Packed Fluoroflex-lined columns complete with Fluoroflex distributor and support plates and Raschig rings can be fabricated in sizes up to 10 inch diameter.

■ **Fluoroflex preflanged piping** eliminates cutting chamfering, cleaning, welding, scale, flux, weld spatter and

SEE US AT THE CHEMICAL INDUSTRIES SHOW, BOOTHS 893, 895, 897.



PRODUCT LOSSES

annealing—minimizes the need for gaskets, hangers, supports, and anchors as required for non-metallic piping.

■ **Fluoroflex reinforced bellows** absorb vibration loads on centrifuges and pumps, and reduce packing leakage. They correct misalignment and expansion-contraction problems on rigid vessels, towers, heat exchangers, etc.

■ **Fluoroflex transfer hose** combines contamination-free hose and flanges with rugged flexibility. Prevents clogging of strainers at critical moments of charging and unloading vessels, tank cars, etc.

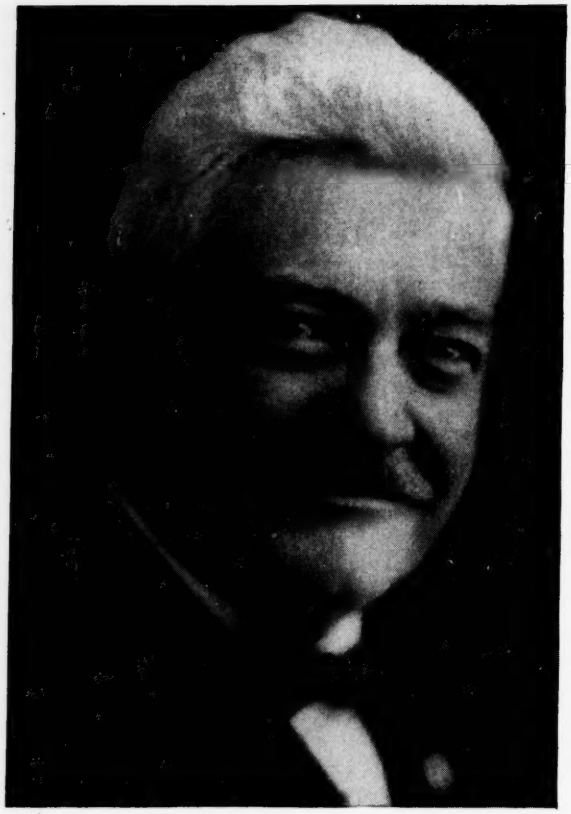
■ **Fluoroflex dip pipes, spargers, and thermowells** provide the protection of Teflon with the strength of steel to withstand severe agitation or viscous materials without danger of damaging expensive reaction vessels.

If you have corrosive fluid-handling problems, SPECIFY FLUOROFLEX. Write to Resistoflex Corporation for detailed information today, or ask our local service engineer to call. Plants in ROSELAND, N. J., Anaheim, Calif., Dallas, Tex. Sales offices in major cities. *Resistoflex T.M. †DuPont T.M.

RESISTOFLEX
RELIABILITY

COMPLETE SYSTEMS FOR CORROSIVE SERVICE

N. Y. COLISEUM • NOV. 27 TO DEC. 1



Newark

50 YEARS PLUS

in Wire Cloth Making In Back of Us...with a outstanding record of important pioneerin developments.

50 YEARS PLUS

in Wire Cloth Making Ahead of Us...continuin with that same pioneering spirit to do more thing and better things in the broad field of wire cloth

Newark Wire Cloth Company, as a corporation, was started in 191 but the "know how" that formed the nucleus of the business the came from its founder, John C. Campbell, a wire cloth maker fro boyhood apprenticeship. Beginning at the age of 14 and workin from 7 in the morning to 6 in the evening—with an hour out for dinn —he literally grew up in the business. When he started NEWAR WIRE CLOTH COMPANY, he knew wire cloth making from A to But even better, he was capable of passing his ski and ingenuity to others. From that day to this the company has bee responsible for many wire cloth "firsts" in the United State

We would be pleased to have you visit our booth at th Chemical Exposition, New York Coliseum next Novembe and to discuss any problem you might have where o experience in the manufacture and use of wire clo might be helpful.

Newark Wire Cloth COMPANY

For example:

BFWW ... (Before First World War) the company was the first to draw phosphor bronze wire and to weave the wire cloth of that metal. The 'first' included the development of the process for making phosphor bronze suitable for drawing fine weaving wire. Another first of the pioneering kind was the use of monel.

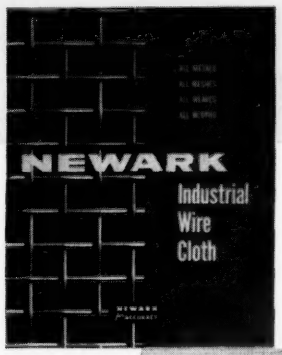
BFWW ... produced the first 'filter grade' wire cloth for use in the beet sugar industry, including 20 x 300 and 28 x 500 mesh, two pioneering achievements.

1920 ...produced the first 250 mesh cloth of any metal in the United States.

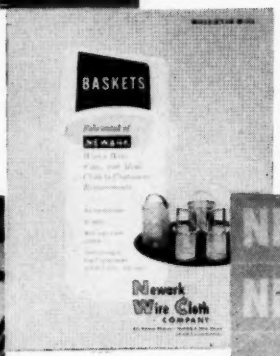
1921 ...produced the first 325 mesh cloth which—and this may be of interest—requires 7800 feet of wire for one square foot of cloth.

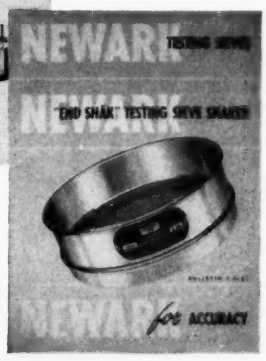
1927 ...produced the first 400 mesh cloth which requires 9600 feet of wire for one square foot.

1939 ...produced the first 100 x 1000 mesh cloth.



We shall be glad to send literature on the following items:
General line of Newark Cloth, Parts and Inserts of Wire Cloth, Testing Sieves, Wire Baskets.

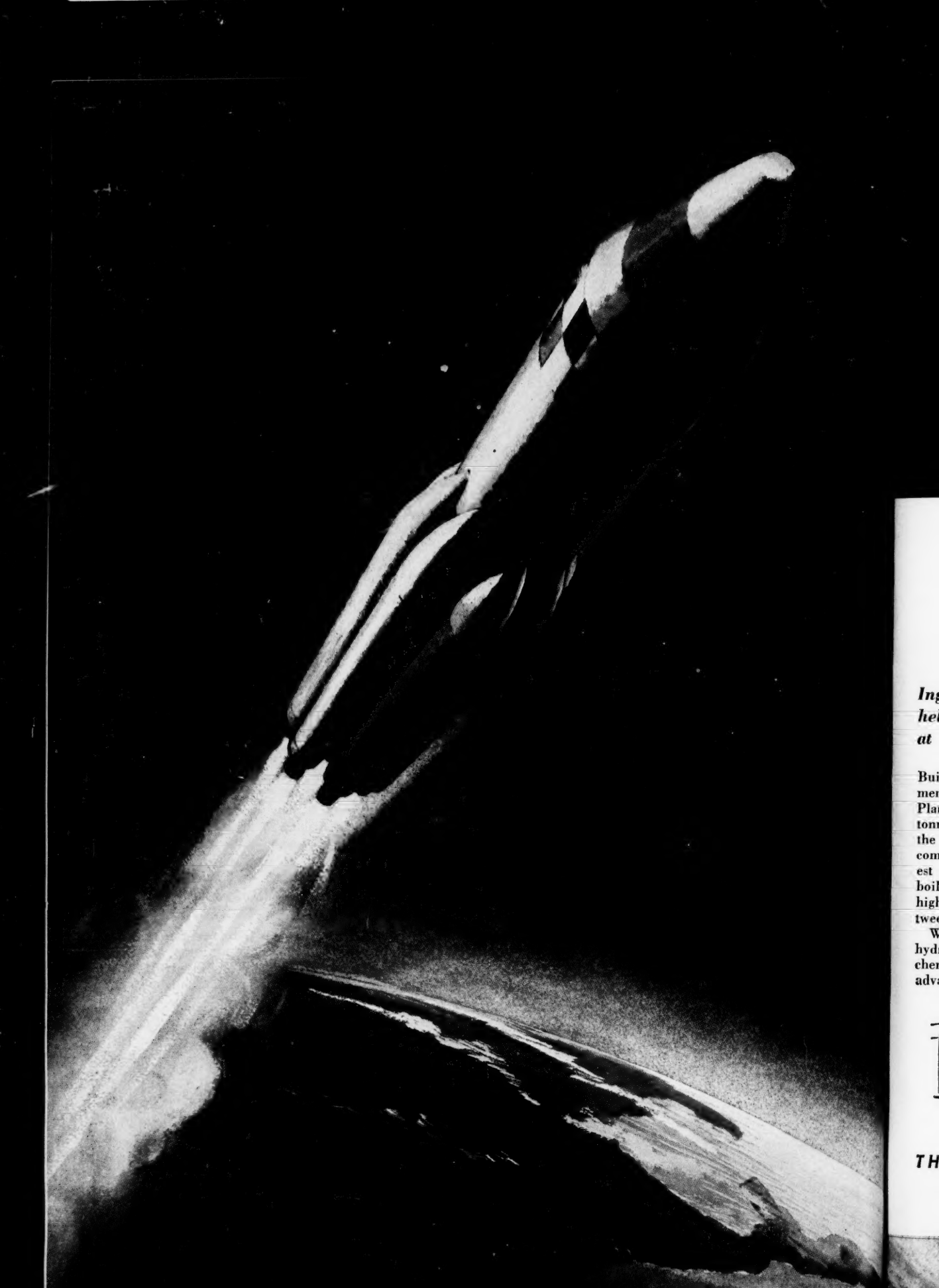




So much for a few brief "pioneering" notes. Today, Newark Wire Cloth Company can supply (1) wire mesh cloth in sizes ranging from 4 inch space to 400 mesh in all commercially available metals; (2) filter cloth in various weaves of standard and corrosion-resisting metals; (3) inserts and other parts of fabricated wire mesh without limit as to size, shape, mesh, number of pieces; (4) complete line of Testing Sieves to NBS, ASTM and ASA Standards.

Newark was and continues to be a pioneering wire cloth company but along with that, it has the equipment, skilled workmen and experience to take care of industry's most exacting requirements.

Newark Wire Cloth COMPANY
351 Verona Avenue Newark 4, New Jersey
Teletype: NK607 • Tel.: HUmboldt 3-7700
Representatives in all principal industrial areas



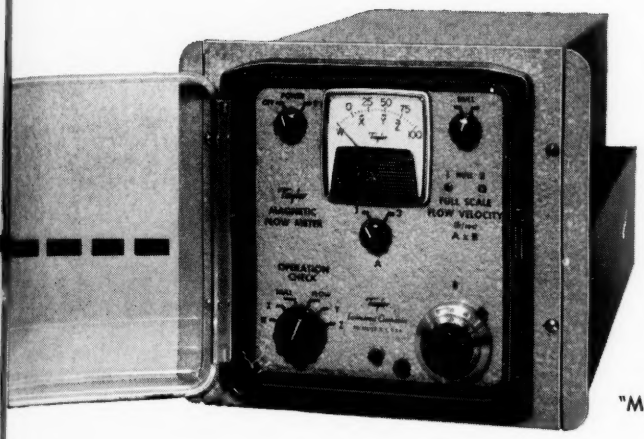
712NE
"MAG-PIPE" Sensing Head

Taylor presents a **MAGNETIC**

OUTSTANDING FEATURES

- High accuracy—½% of full scale on most ranges.
- Full scale velocities as low as ½ ft./sec., at only slightly reduced accuracy.
- Conductivity range—as low as distilled water.
- Rangeability—½ to 30 ft./sec. full scale calibration, continuous vernier adjustment.
- Amplifier—solid state.
- Ideally suited for long transmission runs to a central control panel.
- Output signal—1-5 ma DC into any load from 0-3000 ohms. (Electro-Pneumatic Transducer or TRANSCOPE Electronic Control System).

Taylor Instruments



717TE
"MAG-PIPE" Transmitter

FLOWMETER TRANSMITTER WITH 1/2% ACCURACY

The new Taylor "MAG-PIPE" Magnetic Flowmeter Transmitter is a high quality, high performance transmitter with an output signal of 1-5 ma suitable for transmission over long distances. It can therefore be used with miniature receivers and controllers in central control rooms.

It is designed to measure flow of fluids with an electrical conductivity as low as that of distilled water. It is ideally suited for very low flows, viscous liquids and liquids containing suspended solids, since the flow is not in any way restricted by the primary element.

The "MAG-PIPE" sensing head is mounted in the flow line. It comprises a flow tube, an AC magnetic circuit and two electrodes. The sensing head housing is "hose-down proof" (explosion-proofing optional), and has Van Stone type flanges for easier, faster installation.

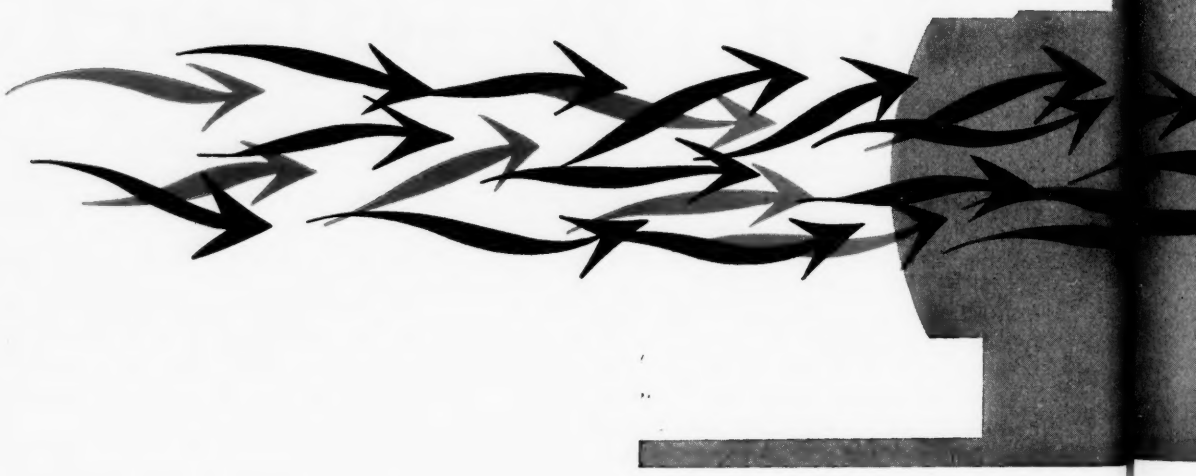
The transmitter employs *solid state* components, being fully transistorized for long-term reliability. It is standard in fixed-range form, in which case calibration is factory set at the desired range. Optionally available with a full-scale vernier adjustment on two ranges. A built-in output meter doubles as a circuit checking device.

The "MAG-PIPE" Flowmeter Transmitter is in production. Consult with us on your difficult flow measurement problems. See your Taylor Field Engineer or write for Bulletin 98418. Taylor Instrument Companies, Rochester, N.Y., and Toronto, Ontario.

MEAN ACCURACY FIRST

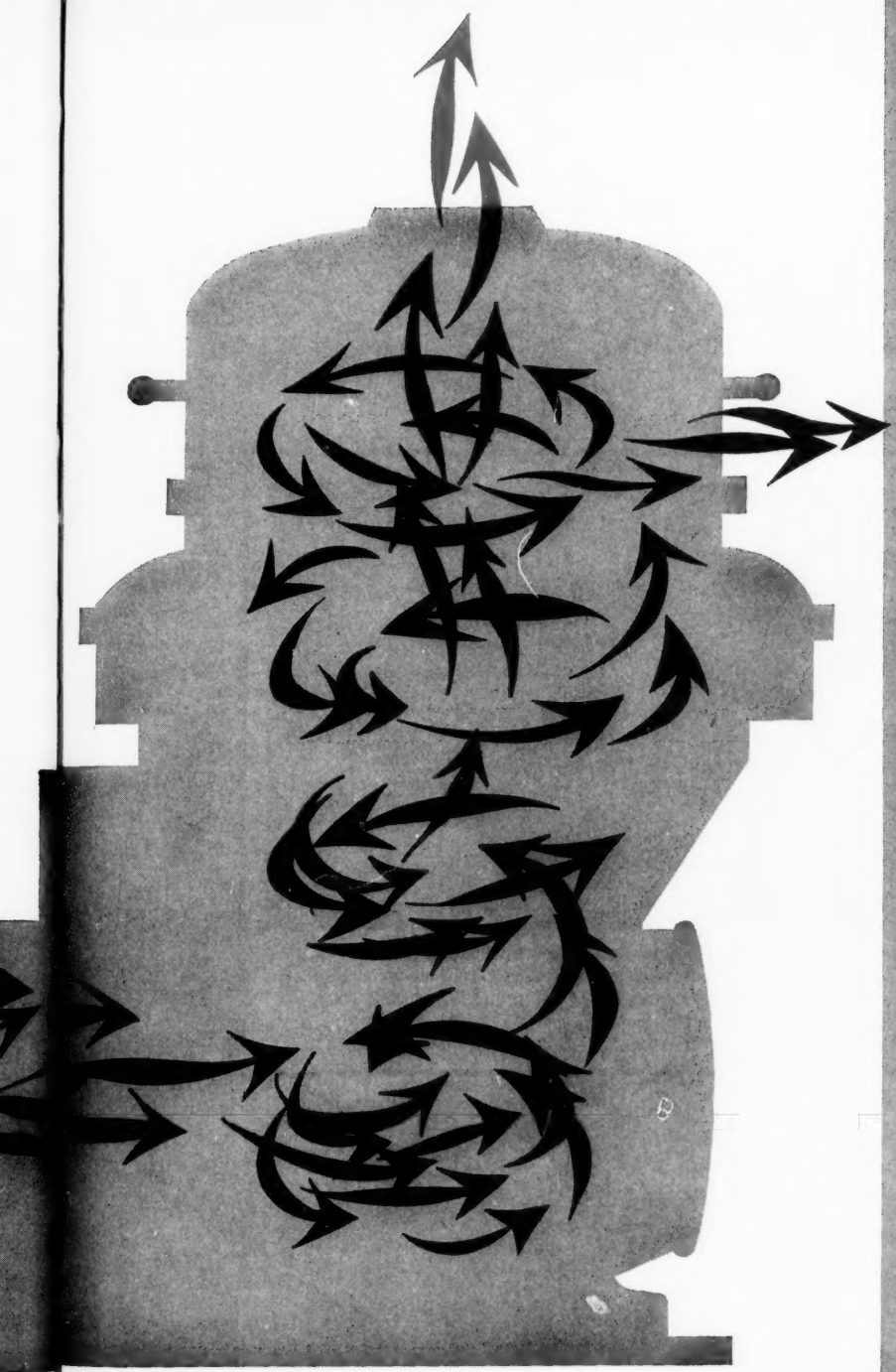
6000 G's give instant on-stream separation or clarification in

DE LAVAL PROCESS CENTRIFUGES

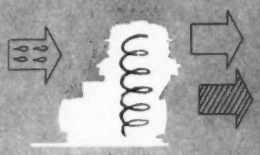


Modern on-stream separation of liquid-liquid phases is as simple as this: pipe the product mixture into the process centrifuge. It is instantly separated into its heavy and light phases, which are continuously discharged. Tremendous gravity forces are used to provide the wide range of liquid-liquid-solid separations described here. These separations are finding rapidly expanding applications in continuous-flow processing—replacing bulky settling tanks and batch filter systems. More important, De Laval Process Centrifuges perform separations of types and efficiencies not previously possible—opening up entirely new process potentials. Information on many such processing modernizations is available from De Laval.

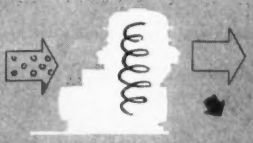
A sound look at your own present or planned



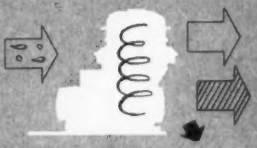
BASIC PROCESS APPLICATIONS:



LIQUID-LIQUID: Separations of immiscible liquids range from removing trace moisture in oils to high-flow-rate separation of reaction product mixtures. Volatile liquids can be processed under pressure.



LIQUID-SOLIDS: Suspended solids of any fineness are instantly removed to give crystal clear product streams. Sediment is removed periodically for disposal or recovery. When suspended solids represent a significant proportion of the product stream, the solids can be removed continuously and automatically by specially designed De Laval centrifuges.



LIQUID-LIQUID-SOLIDS: The removal of sediment or solids in no way affects or handicaps the separation of immiscible liquids where such 3-phase systems exist.

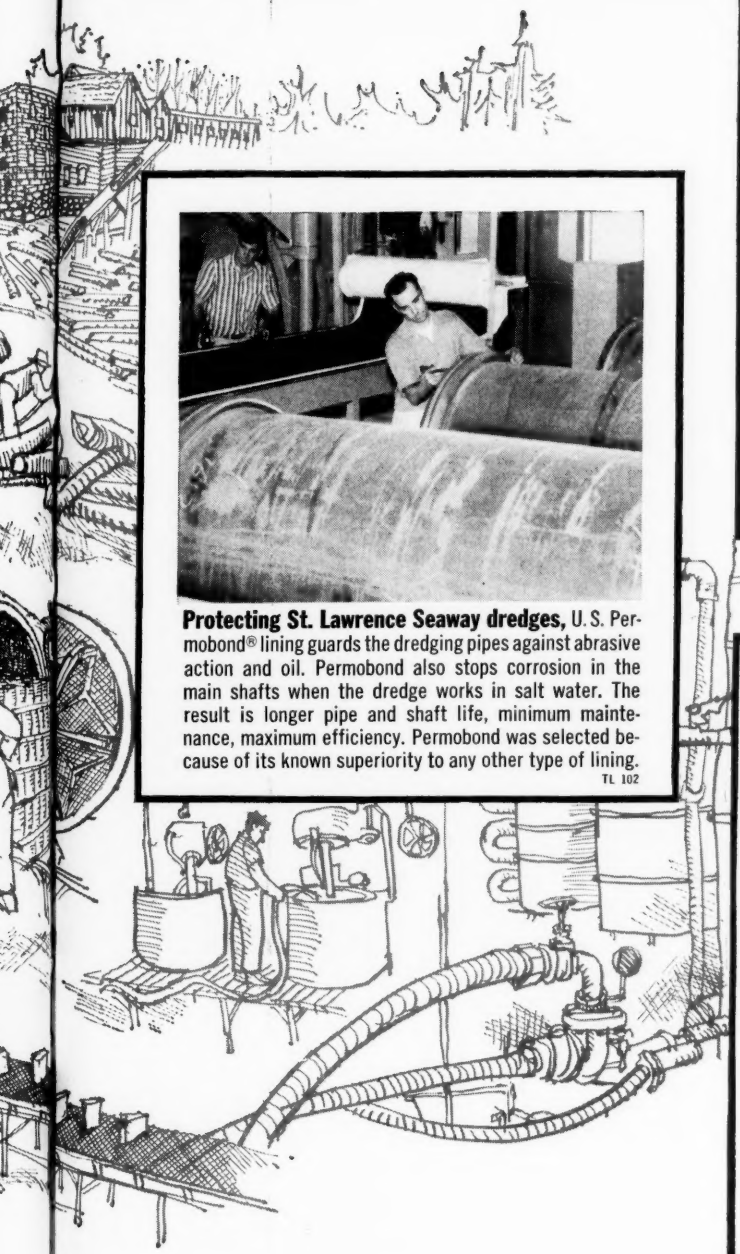
PROCESS DESIGN FACTORS: Materials of construction can be matched to operating conditions. Operating pressures up to 150 lbs. p.s.i. can be handled, permitting efficient processing of volatile and air sensitive materials. Capacities of De Laval's Process Centrifuges range from 2 to 12,000 gallons per hour—and the very largest requires only 12 sq. ft. of floor space.

process by a De Laval engineer can quickly determine the process benefits and economies. Start by requesting our booklet on centrifuge types and their applications.

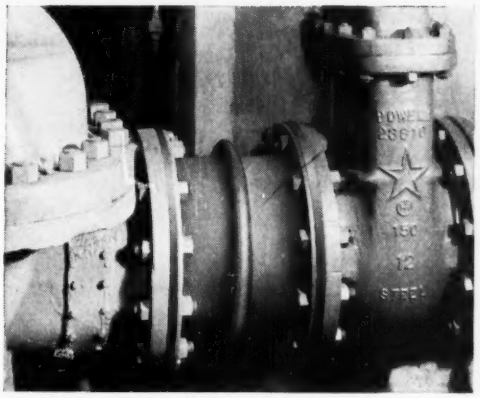
THE DE LAVAL SEPARATOR COMPANY

Poughkeepsie, N. Y.
5724 N. Pulaski, Chicago 46, Ill.
201 E. Millbrae Ave., Millbrae, Cal.
DEPT. CE-9

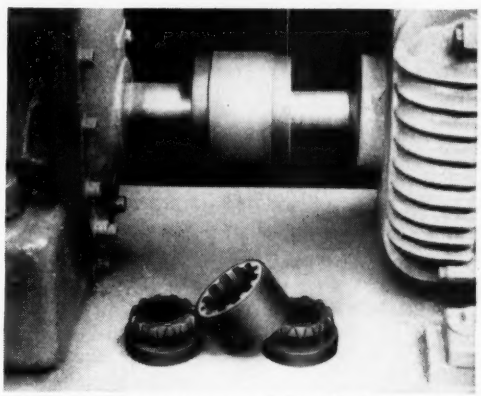
DE LAVAL



Protecting St. Lawrence Seaway dredges, U.S. Permobond® lining guards the dredging pipes against abrasive action and oil. Permobond also stops corrosion in the main shafts when the dredge works in salt water. The result is longer pipe and shaft life, minimum maintenance, maximum efficiency. Permobond was selected because of its known superiority to any other type of lining.
TL 102



Name your chemical, name your processing temperature, and you'll get a customized U.S. Chemex Expansion Joint designed to operate on your piping with maximum efficiency. Neither flow surge, pressure, temperature, nor corrosive action will cause money-losing down-time when your processing equipment is protected by chemical-resistant U.S. Chemex Expansion Joints.
EJ 103



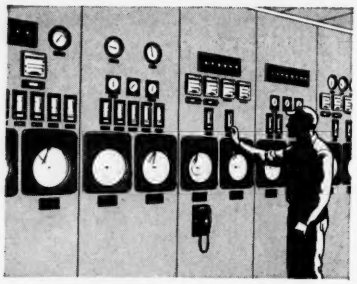
The low cost and ease of installation of U.S. PowerGrip Flexible Couplings please P. H. Glatfelter Paper Company. This company also likes the way these couplings compensate for shaft misalignment, absorb sudden shocks with ease. PowerGrip Couplings have a built-in clutch action for "give" in case of overload, prevent damage to machinery, require no maintenance.
FC 102

For every industrial rubber product need, turn to US. For Conveyor Belts, V-Belts, the original PowerGrip "Timing"® Belt, Flexible Couplings, Mountings, Fenders, Hose and Packings . . . custom-designed rubber products of every description. Discover why U.S. Rubber has become the largest developer and producer of industrial rubber products in the world. See your U.S. Rubber Distributor or contact US directly at Rockefeller Center, New York 20, N. Y.

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

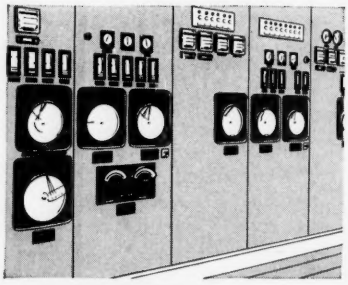
US RUBBER

United States Rubber
MECHANICAL GOODS DIVISION



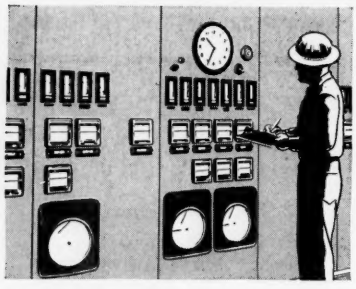
1951

Foxboro Consotrols
selected for new Celanese plant in Pampa, Texas



1952

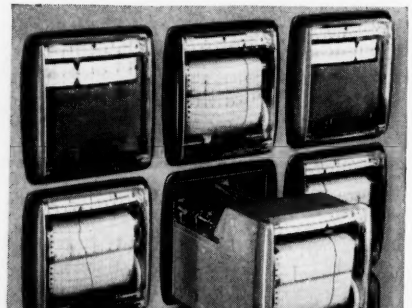
Foxboro Consotrols
selected for new Celanese special products and vinyl acetate units at Pampa



1957

Foxboro Consotrols
selected for new Celanese acrylate unit at Pampa.

. . . and now Foxboro Consotrol re major ne ela



Foxboro M/54-58 Consotrol Recorder-Controllers feature full-scale 4-inch vertical-travel chart; ready adaptability to changes in processing requirements. Instruments mount on 7-inch centers for minimum panel size. Unique "floating disc" M/58 Controller has unmatched stability, sensitivity, and reliability.

Thirty million pounds of acrylates a year is the capacity o newly-expanded petrochemical plant of Celanese Che Company, Pampa, Texas.

Foxboro Pneumatic Consotrol Instruments have bee nerve centers of the entire plant since the first panel was ins in 1951. Why the continued preference? M. A. Gann, Instru Supervisor, puts it this way:

"We have over a thousand instruments in this plant. Acc

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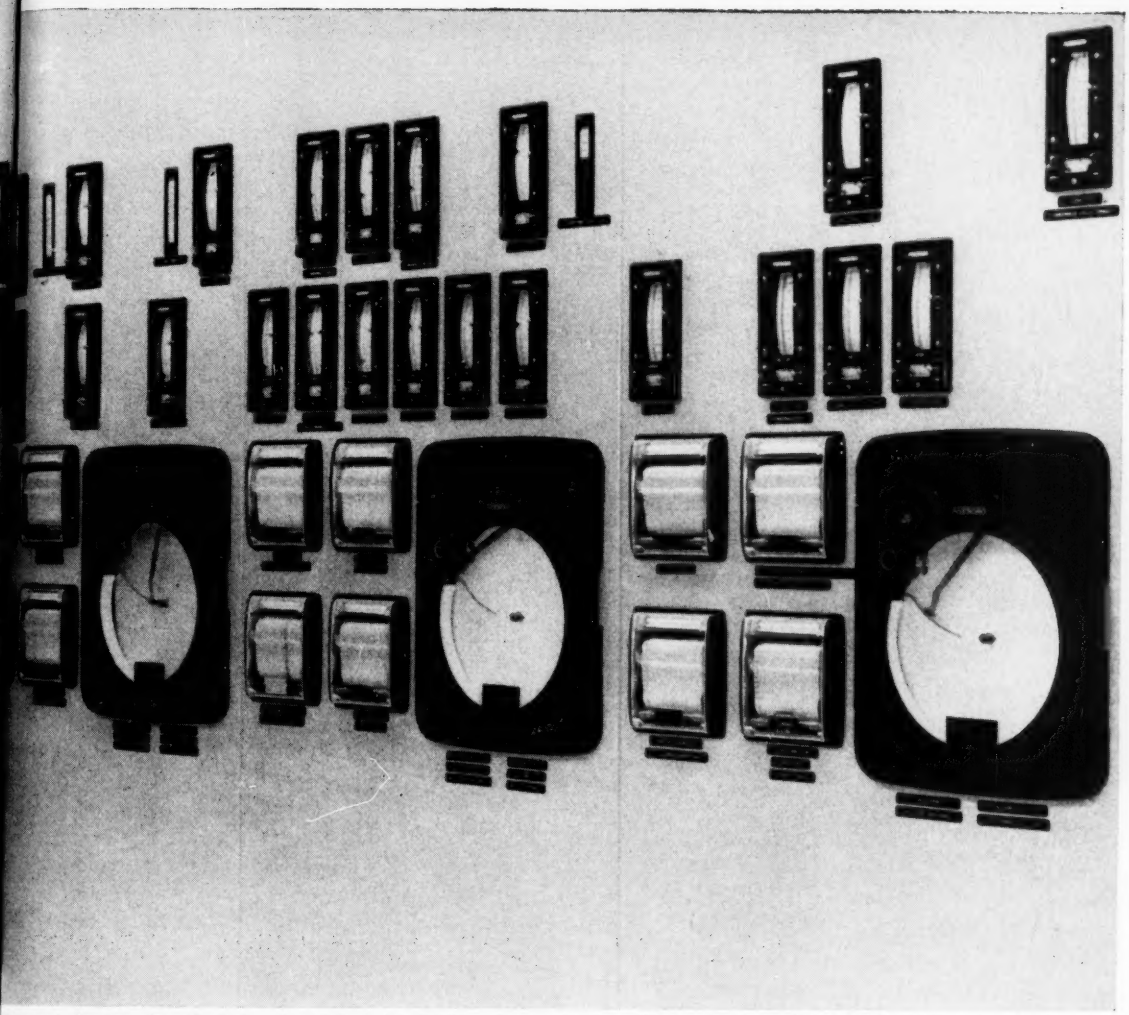
Newest
Celanese



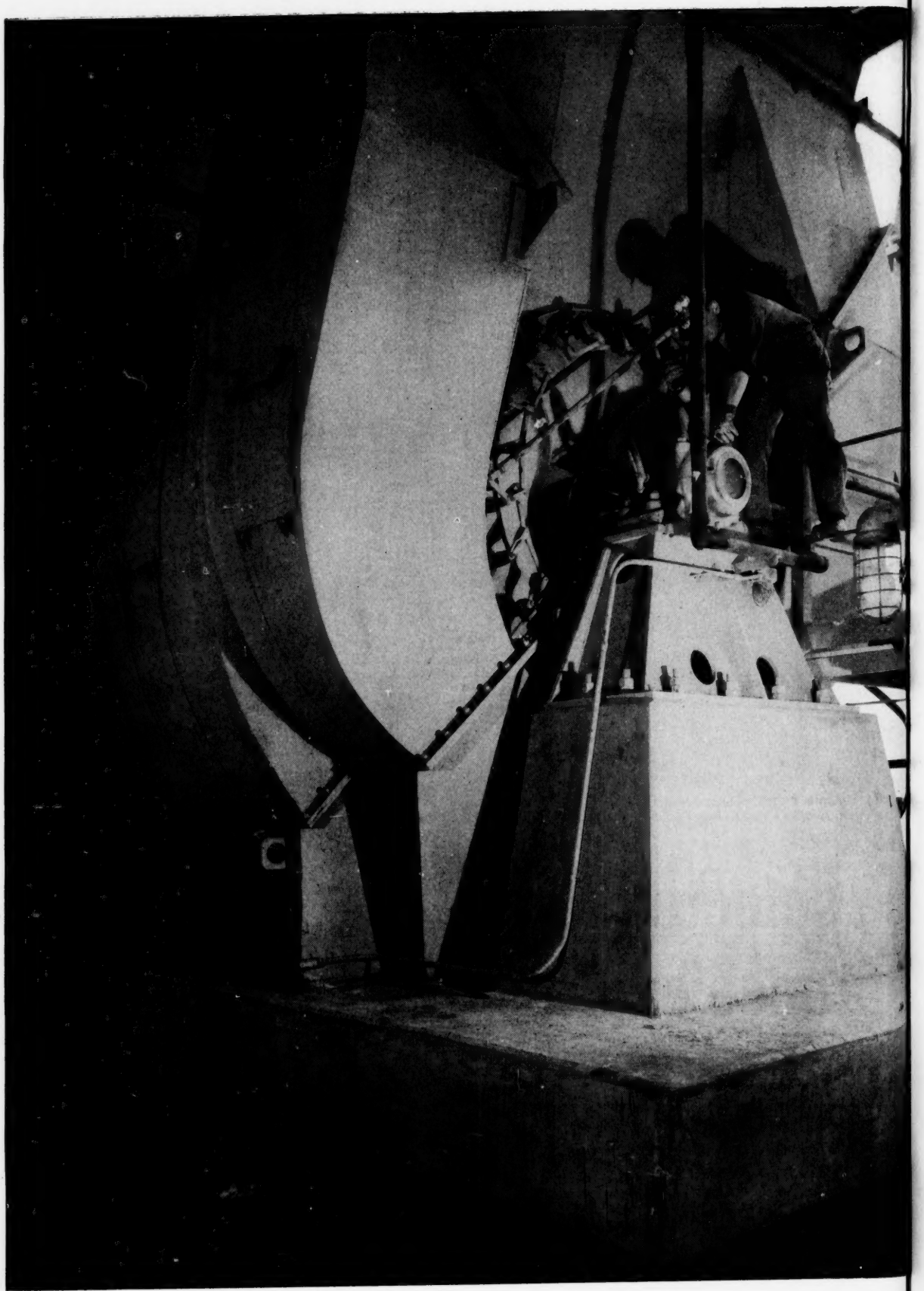
Newest Foxboro Panel, designed and built by Foxboro for Celanese Chemical's Pampa, Texas plant, controls processing in new Higher Acrylates Unit. Foxboro flow, temperature, and pressure transmitters are also used exclusively.

re selected again for elanese expansion at Pampa!

liability, and low maintenance are absolute musts, and we've und that Foxboro Consotrols consistently deliver on all counts." Foxboro's M/54-58 Recorders-Controllers, for example, pro- e repeatability of ±0.1%, complete "pull-out" convenience, d the most stable control action of any instrument in the field. Write for Bulletins 13-18 and 13-19. Get the whole story on nsotrols. See what they can do for *you*. The Foxboro Company, 9 Neponset Ave., Foxboro, Massachusetts.

FOXBORO
REG. U.S. PAT. OFF.

*Reg. U.S. Pat. Off.



RD Fan used for induced draft on basic oxygen furnace of large steel producer. There are four identical units, each producing 325,000 cfm against a static pressure of 15" wg at 550° F.

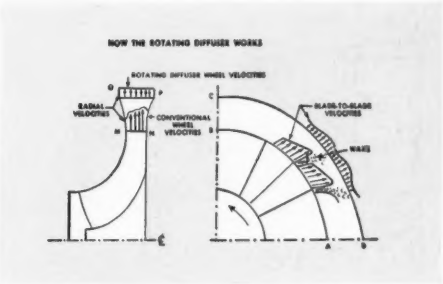
JOY RD FANS CAN PROVIDE PRESSURES UP TO 4.5 PSI AND CAPACITIES UP TO 600,000 CFM

Joy RD Centrifugal Fans, based on a new concept in fan design, can provide any volume of air or gas at pressures up to 4.5 psi in a single stage. This means important savings in initial cost. An equally important saving is their high efficiency over a wide range of volume, which is especially important where load fluctuates. Surging, even on parallel operation, is no problem because the RD Fan is inherently resistant to pressure surge over its entire duty range.

These advantages of the RD Fan are the results of its unique rotating diffuser. Instead of stationary diffusers, the RD diffuser is an integral part of the wheel—added at the blade tips. The rotating diffuser reduces the gas velocity before leaving the wheel and up to 98% of the conversion of velocity to pressure is accomplished with the wheel of the RD Fan.

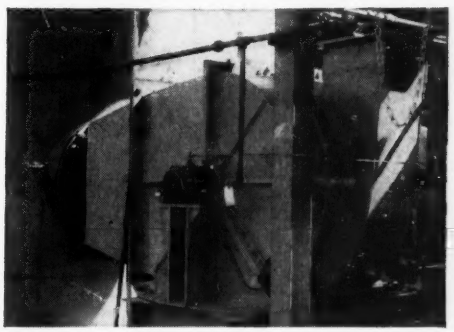
Radial blades in the RD Fan tend to be self cleaning, even when handling dust laden and dirty gases. The rotating diffuser results in low noise levels because of the lower and more regular velocities leaving the wheel and because the blade tips are remote from the cut-off.

The Joy RD Fan is finding steady acceptance in induced draft and forced draft applications in the steel and power industries, in handling chemical process gases, and in heavy duty industrial applications. For extremely dirty or corrosive applications the entire unit may be fabricated of stainless steel. Parts are simple because there are no large castings or close running tolerances. For complete information and duty areas of the RD Fan, write for bulletin 3449-11.



HOW THE ROTATING DIFFUSER WORKS

Studies have shown that radial velocities leaving conventional wheels are unequally distributed, as shown in MN. Also there is fluctuation in the blade-to-blade velocities based on $\frac{nN}{60}$ where n is the number of blades and N is the speed in rpm. The Rotating Diffuser reduces the gas velocity before leaving the wheel, which allows more uniform flow as shown at OP and CD. Without the rotating diffuser, velocities are much higher and erratic as shown at AB and MN, causing turbulence, friction losses.



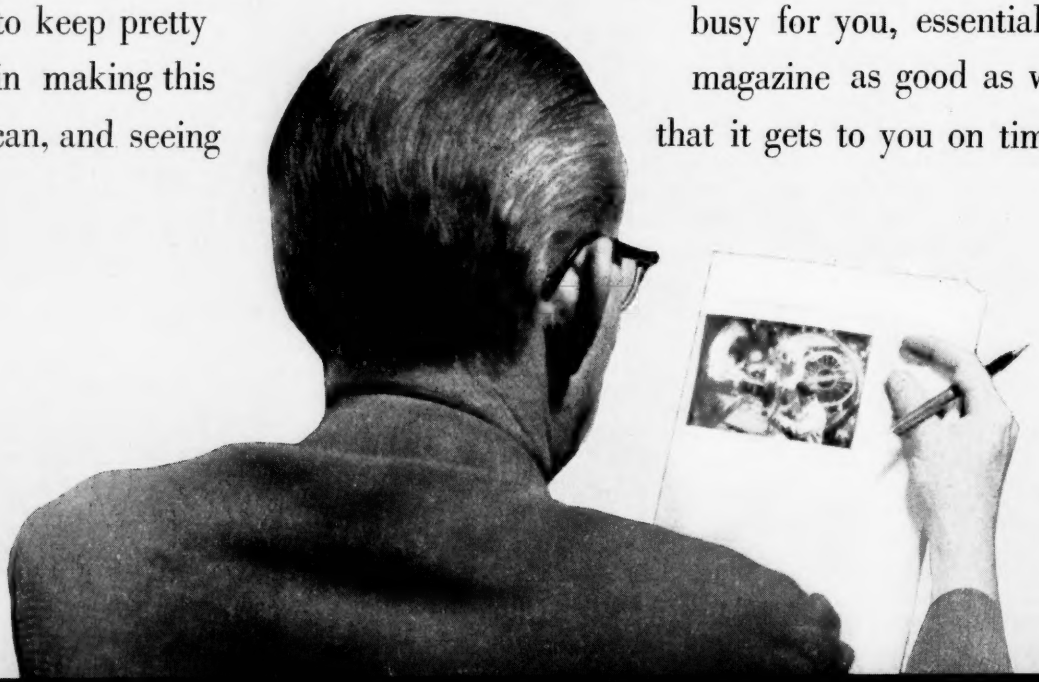
Joy RD Fan at eastern CO_2 plant. Unit has capacity of 27,800 cfm, at 3 psi. Drive is a 450 hp steam turbine.

My name is Les Pope.

I read every issue of CHEMICAL ENGINEERING. I read it from cover-to-cover, every page, literally every word.

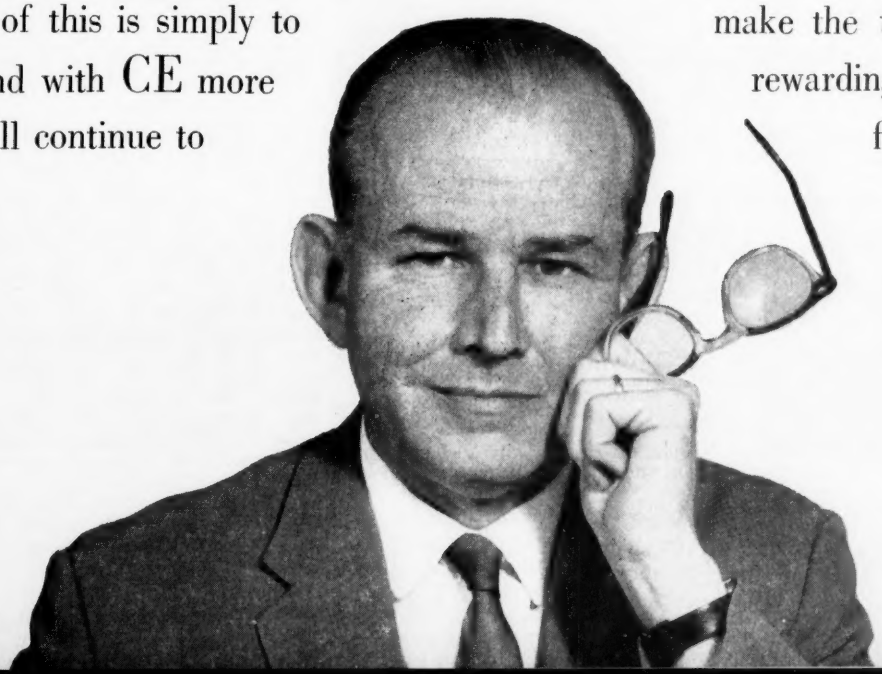
I have been doing this religiously since November, 1939. That was when I joined the CHEMICAL ENGINEERING editorial staff (after a BS in chemical engineering from Columbia and a stint on the staff of Scientific American). I do it for two reasons: *First*, because the first rule we have is that the reader always comes first . . . and this means maximum utility and readability in everything we put into print. *Second*, because as Editor in charge of Production and Presentation, it's part of my job.

Etched in platinum, somewhere in our editorial rooms, there might be a plaque of practice that reads like this . . . "*Ours the task to reason why, to edify, not stupefy.*" So, with about twenty copy-producing editors on the CE staff, to say nothing of news bureau people and contributors, the 6-man Pope combat crew manages to keep pretty busy for you, essentially in making this magazine as good as we can, and seeing that it gets to you on time.

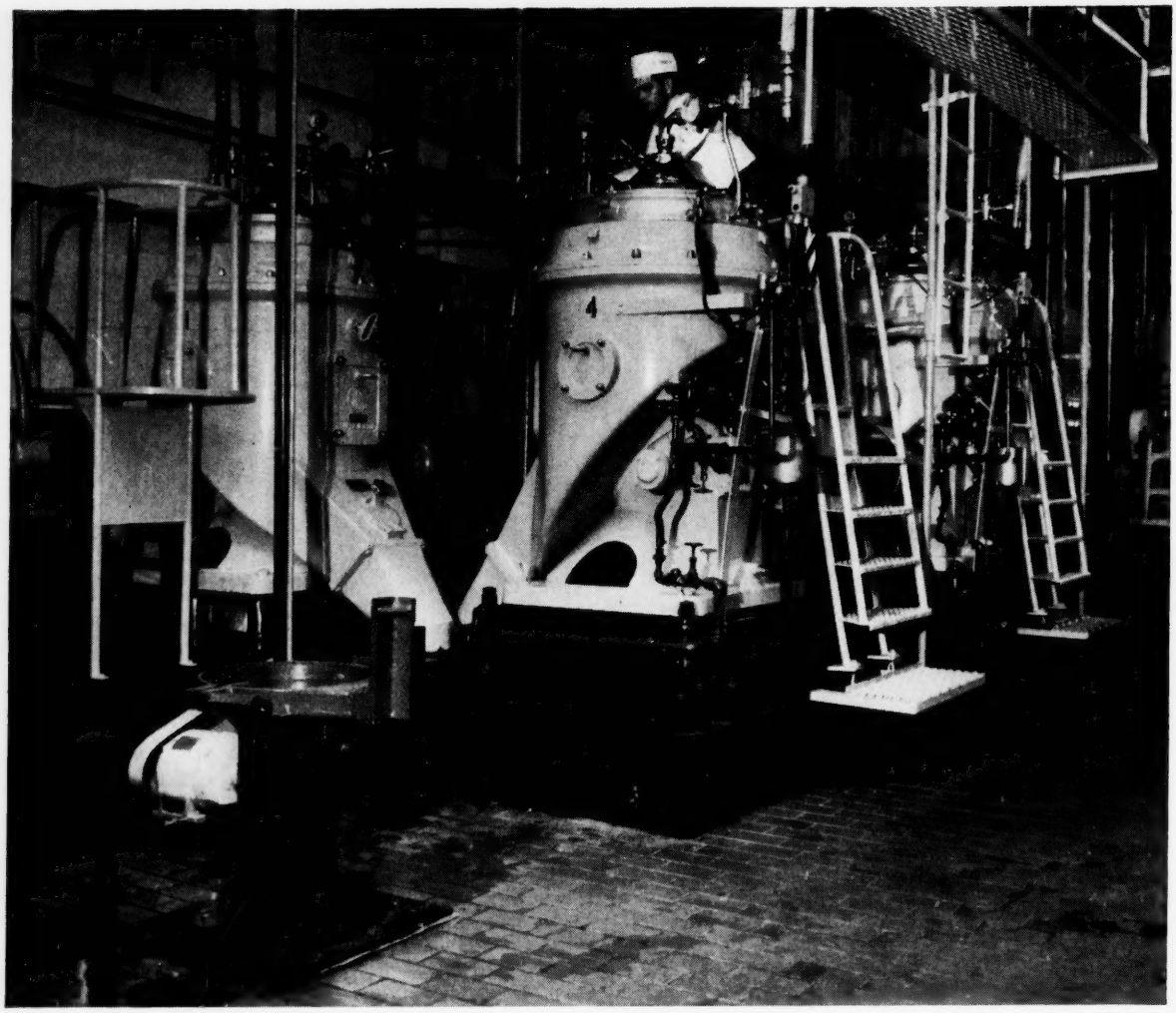


It's intriguing, when you stop and think about it, that good editorial presentation, like good manners, is never conspicuous. You would be much more likely to notice what my associates and myself do when we goof... when we handle a headline with our mittens on; when a graph gets in its own way; when color goes berserk. Isn't that so? But behind our blush we carry on, trying a little harder, and a little wiser. For we know that as an engineer, you are a man of orderly mind, and as an individual of good taste, you want *your* magazine to be distinctive.

In passing, we might mention that we go to infinite pains to make it so... in the selection of a fresh, modern design of display type for headlines, for instance... in designing our new logotype, our signature... in refining the drawing of CE's long popular flowsheets... in the eye-comfort of type used for text (after all, none of us are growing younger) ...even the ever-loving care with which we use white space, itself. All of this is simply to make the time you spend with CE more rewarding. I hope you'll continue to find it so.



FLUIDICS* AT WORK



Are you losing valuable product in wet sludge?

Take this orange juice packer. He had a separation problem. If he used heavy finishing, he got undesirable pulp ingredients in the juice. Light finishing alone meant lost juice in the wet sludge.

So he installed a new procedure using four Pfaudler® Titan Superjectors. Now he countercurrent-washes the sludge from the light finish and centrifuges out unwanted particles. This gives him the high-quality juice of a single light finish. Practically no product loss, since centrifuged sludge is concentrated to 100% by volume.

Why this centrifuge? Because the Titan alone has the design features which enable you to handle many separating problems with exceptional efficiency.

High separating power. The Titan operates up to 7500 times gravity, much more force than you can get with most continuous machines. Such power makes separations possible where the difference in specific gravity between solids and liquids is as little as 2%.

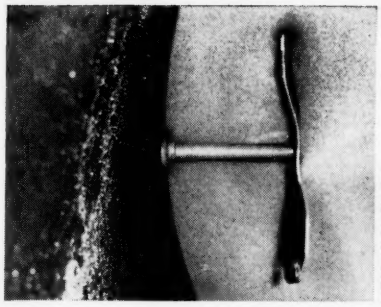
Choice of discharge. You can instantaneously purge the entire contents of the bowl, bleed off solids only, or sequence these two effects as desired. This system of control is known as Selecteject. It is available only in the Titan.

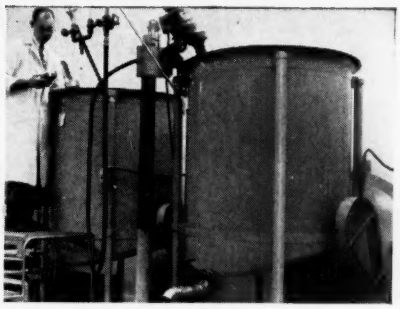
No nozzles. Instead of nozzles you have *slots*. These slots will handle particles up to ⅛" in diameter. They won't clog. They will keep downtime to a minimum.

Triple jet desludging. In most Titans there are separate jets to actuate valves for instantaneous opening, instantaneous closing and sealing the bowl, respectively. This positive, quick action means that complete desludging is done in *less than half* the feed-interruption time common with other machines.

Summing up. This is a high-capacity machine—up to 6000 gallons per hour. It can handle a wide variety of separations, including the tough ones. Like those involving two liquids and solids simultaneously; solids that are only slightly heavier than liquids; liquids that are highly viscous or aerated; particles that are fine, slimy, or abrasive.

Obviously, if the tough ones come easy, the easy ones become just routine with a Titan. Get all the facts for more detailed study. Ask for Bulletin 1002. Write to the address shown on the facing page.





How Strasenburgh fights corrosion with Pfaudlon® 301

This is Pfaudler's plastic coating that is sprayed on and then fired to a base metal. A water suspension form of Hercules Penton,* it offers economical protection against many forms of corrosion.

Case in point: Strasenburgh Laboratories, an ethical pharmaceutical manufacturer in Rochester, N. Y., has a mixing operation involving 3½% of 37% HCl in H_2O at room temperatures. In addition to being corrosive, the product has a highly abrasive, sandlike consistency.

Pfaudlon 301 coated agitators have been in use now for over a year. Previously, stainless agitators had been tried. But this material proved unsatisfactory due to the danger of product contamination from corrosion.

Where can you use it? Check these facts about Pfaudlon 301. It stands up to most acids, alkalies and solvents to 210°F. It is smooth and nonporous. It can be applied as an interior or exterior coating on a wide range of base metals. Many types of equipment can be protected—vessels, pumps and parts, agitators, and fume ducts, to name a few.

Put Pfaudlon 301 to work two ways: (1) On new equipment fabricated by Pfaudler. (2) On present equipment, by having it custom coated. Ten firms are licensed by us to do custom coating.

Bulletin 1007 is the basic reference. Or we'll be glad to answer questions dealing with specific applications.

*Registered trademark for chlorinated polyether manufactured by Hercules Powder Co.

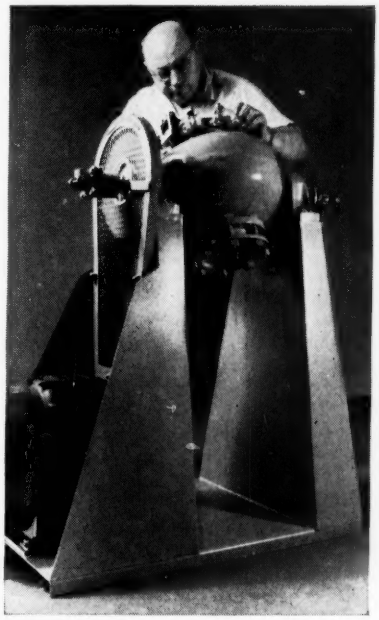
Test small batches in this new, one-foot Conical Dryer Blender

Here in one machine is a whole chemical plant, *sized* for your lab or pilot operations.

It's the new, one-foot (⅓-cu-ft working capacity) Pfaudler Conical Dryer Blender. You can use this dryer blender for concentrating, impregnating, reacting and coating—as well as drying and blending. In fact, since several operations can be performed in a *single* cycle, process time and materials handling are markedly reduced.

Corrosion is *no* problem, since construction is of Glasteel. You can safely handle any acid material (except HF) at elevated temperatures, and alkalies at moderate temperatures. Also, there's no possibility of metallic contamination. And the smooth inside surface inhibits build-up, keeps heat transfer high, makes cleaning quick and easy.

Versatile, timesaving, efficient—that's the basic story on the Pfaudler Conical Dryer Blender, ready now in the one-foot size for lab or pilot plant. Ask for Data Sheet No. 51. Also available: Bulletin 963, providing specs for production models with working capacities from 2.6 to 165 cubic feet.

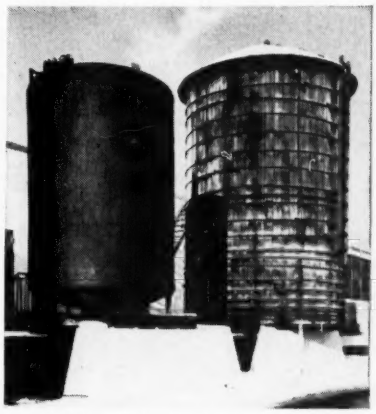


Glasteel storage tanks now available for use to 180°F.

Take a good product and make it better.

That's what we've done with Glasteel storage tanks, the ones that are ideally suited to corrosive, sticky, or ultra-pure liquids. The "better" is in the upper temperature limit — now increased to 180°F for tanks up to 10,000 gallons.

Which means that these tanks are more versatile and a better investment than ever. Made of Glasteel (glass inside, steel outside), they have good corrosion resistance; a fire-polished, nonporous inside that's easy to clean; and an inert product-contact surface.



Hot (150° to 180°F) water for a laundry is stored in the 5000-gallon Pfaudler Glasteel tank at left. This tank has been in continuous use for 4 years. Wooden tank at right is for cold-water supply.

You can get Glasteel tanks in sizes from 500 to 35,000 gallons, horizontal or vertical. Standard accessories include turbine or impeller agitators, drives, manhole covers, valves and gauges to meet your specifications. Also, heat can be applied with thermo panels.

The new 180°F limit applies to the type of Glasteel formulated for storage of corrosives. And, as of now, it's available only in sizes to 10,000 gallons. Through 20,000 the limit is still 125°F. The really big tanks (up to 35,000 gallons) are made of a Glasteel designed for use with "neutral" products.

More facts? Write for just-issued Bulletin 1012.

Address all inquiries to our Pfaudler Division, Dept. CE-91, Rochester 3, N. Y. In Canada, contact Pfaudler Permutit Canada Ltd., Toronto.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

Hermetic... they're Leakproof!

NEW 'BUFFALO'

CAN-O-MATIC® *PUMPS*

with self-adjusting bearings

Now, from Buffalo Pumps, a leakproof line of totally enclosed hermetic pumps so simple in design they can be taken apart and re-assembled with open-end wrenches and a screwdriver.

Designed for the chemical, petrochemical, atomic energy, and marine industries, the new Can-O-Matic's are the most practical, durable and easily maintained pumps in the hermetic field.

Long-life bearings represent a great new advance in canned pump design. Lubricated by the liquid being pumped, they absorb both radial and axial thrusts... automatically compensate for bearing and journal wear. Toxic or volatile, liquids cannot escape... air cannot leak in.

Thirteen sizes with 1" to 5" discharges are now available for a wide range of applications. Standard units with stainless steel rotor cans are designed for 120 psig and 40° through 250° F. operations. Special models are available for higher pressures and temperatures, and a variety of dangerous corrosive liquids.

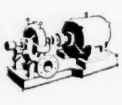
For additional information and specs, contact your resident Buffalo representative, or write direct for Advance Bulletin 977.

"Buffalo" PUMPS

BUFFALO PUMPS DIVISION
BUFFALO FORGE COMPANY
Buffalo, New York
CANADA PUMPS LTD., KITCHENER, ONT.

'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.



'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

Att'n:
Kiln Operators with Gas Cleaning Problems on Lime, Coal, Cement, Asphalt or Aggregate

For air pollution control, and for solids recovery from kiln gases, the S-F Venturi scrubber's unique design assures reliable performance without maintenance problems. The Chemico S-F scrubber was specifically designed to permit the recycle of slurries with high solids content. It has no nozzles, trays or jets to plug, and it completely eliminates build-up at the gas inlet.

Chemico S-F Venturi scrubbers are now operating efficiently on kilns throughout the country. For example, a unit installed one year ago on a reburnt lime kiln in California has never caused a kiln shutdown. This Venturi scrubber is designed to handle 35,000 Cfm of hot gases flowing at 450°F. It provides gas cleaning efficiencies of 99%+ on lime dust and 90%+ on soda fumes, resulting in a clean stack.

If you are considering the installation or replacement of gas cleaning equipment, learn more about Chemico scrubbers by writing to: CHEMICO—Gas Scrubber Division. All inquiries will receive prompt attention.

CHEMICO

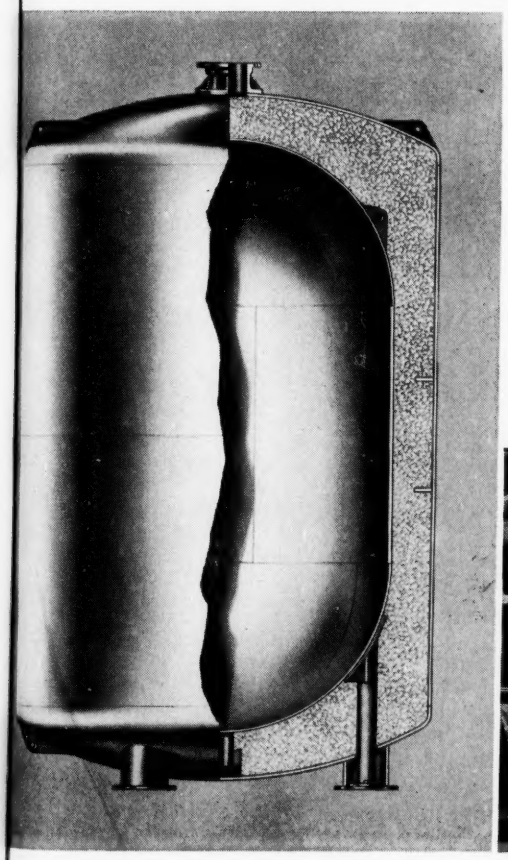
Chemical Construction Corporation, Gas Scrubber Division
320 Park Ave., New York 22, New York

FERNDALE, MICH. CHICAGO, ILL. LOS ANGELES, CALIF. HOUSTON, TEX. BARTOW, FLA. BIRMINGHAM, ALA. PITTSBURGH, PA.

FOR AIRCO

43 LIQUID OXYGEN TANKS

BY PDM



These 9% nickel 5850-gallon insulated liquid oxygen storage containers are now serving AIR REDUCTION customers around the country in the fields of missiles • steel • chemicals • metal fabrication.

This large order from Air Reduction Sales Company reflects the nationally recognized ability of Pittsburgh-Des Moines Steel Company to handle cryogenic storage vessel fabrication on schedule, to the most exacting specifications. Each of these units, supplied by AIRCO for in-plant customer use, consists of a 9% nickel inner tank 9′ dia x 16′3″ high, contained in a carbon steel outer tank 11′6″ x 20′ with vacuum-perlite insulation. The inner tank, built to ASME code, is grit-blasted, 100% X-rayed, nitrogen purged and stress relieved, hydrostatic tested, dried by hot filtered air and Freon de-greased. • May we quote on your requirements?

Left to right: Cutaway view of liquid oxygen unit, showing 9% nickel inner shell and vacuum-perlite insulation. • Inner tank under construction. • Shop view of carbon steel outer tank. • Completed unit undergoing mass spectrometer helium leak test.

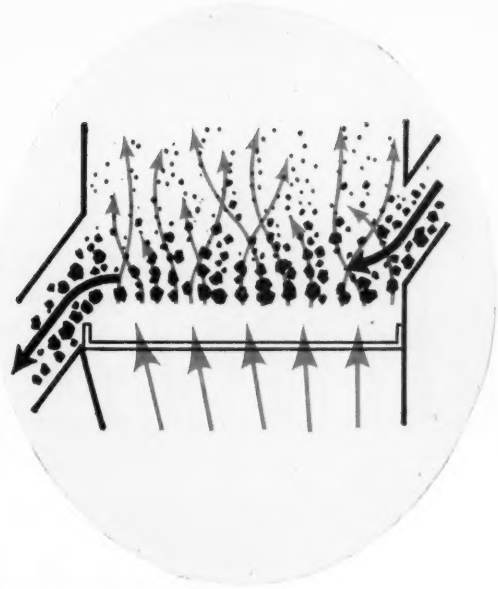
PDM
STEEL STORAGE TANKS

PITTSBURGH-DES MOINES STEEL COMPANY

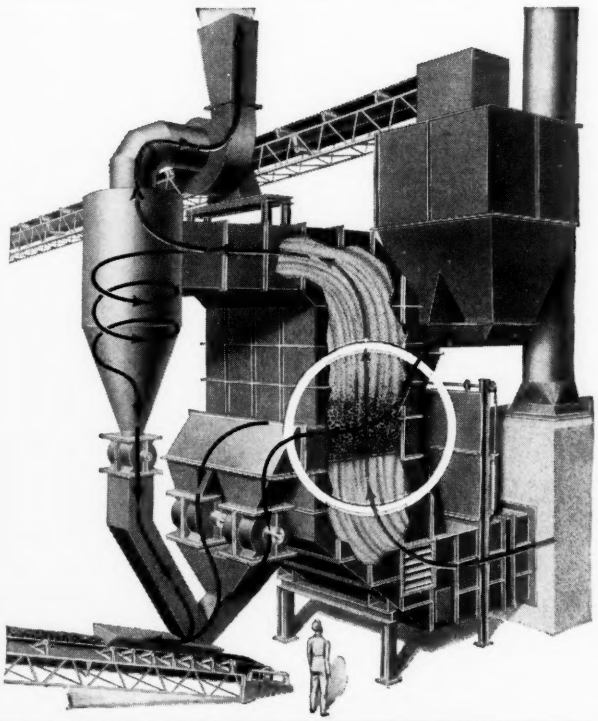
Plants at PITTSBURGH, WARREN, BRISTOL, PA. • BALTIMORE • BIRMINGHAM • DES MOINES
PROVO, UTAH • CASPER, WYO. • SANTA CLARA, FRESNO, STOCKTON, CALIF.

PITTSBURGH (25)	Neville Island	EL MONTE, CALIF.	P.O. Box 2012
WARREN, PA.	P.O. Box 660	NEW YORK (17)	200 East 42nd Street
BALTIMORE (26)	P.O. Box 3459, Curtis Bay Station	NEWARK (2)	744 Broad Street
BIRMINGHAM (8)	P.O. Box 8641, Ensley Station	CHICAGO (3)	679 First National Bank Bldg.
DES MOINES (8)	1015 Tuttle Street	ATLANTA (5)	361 East Paces Ferry Rd., N.E.
PROVO, UTAH	P.O. Box 310	DALLAS (1)	Suite 1703, Southland Center
SANTA CLARA, CALIF	P.O. Box 329	DENVER (2)	323 Railway Exchange Bldg.
		SEATTLE (1)	500 Wall Street

PERFECT SPOT to dry granular solids



LINK-BELT *FLUID-FLO DRYER* gives you continuous, automatic processing . . . with minimum product loss and degradation



Here's a dryer you can *trust* with your product. Working with high thermal efficiency, Link-Belt's Fluid-Flo quickly and gently removes moisture from granular solids. Residence time can be varied to suit conditions. Suction operating pressure assures that all gases pass through dust collectors, preventing the loss of dry fines.

Fluid-Flo's initial cost is *low*. And count on low maintenance costs, too, because there are no moving parts . . . air alone does all the work.

HOW FLUID-FLO WORKS

Material is fed over a constriction plate through which hot gases flow. The drying gases "fluidize" the material . . . suspend and completely surround each particle, promoting rapid moisture reduction. The suspended material travels horizontally above the constriction plate into a chute and is discharged at a relatively low temperature through a motorized air lock. Throughout the operation, Fluid-Flo temperature is *automatically* controlled to assure maximum drying efficiency.

TEST YOUR PRODUCT

For a laboratory analysis of Fluid-Flo's performance in drying your product, contact your nearest Link-Belt office. Ask, too, for Folder 2909.

OTHER WAYS TO USE LINK-BELT FLUID-FLO DRYER

AS A COOLER—Air at ambient or lower temperature is drawn through the bed of material. The material loses heat by transfer to the vapor particles in the air, or by absorption through evaporation of its moisture.

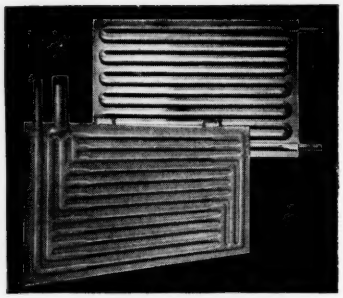
AS A REACTOR—Heated air or gases can be used to produce a chemical reaction in the material. Such operations as roasting, baking or calcining are possible in this unit.

AS AN ELUTRIATOR—The unit can dry and size materials simultaneously. Dust and fines are carried off and trapped in the dust collector.

LINK-BELT

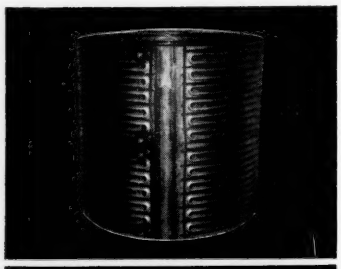
COOLERS • DRYERS • ROASTERS

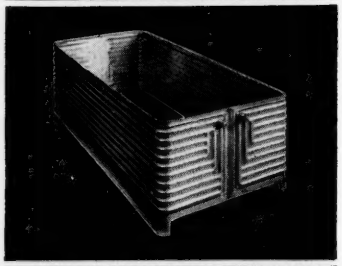
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses and District Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World. 15,727

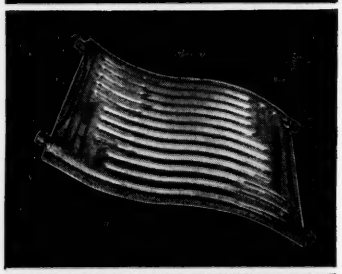


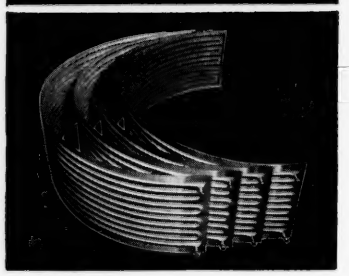
PLATECOIL®

"STANDARD" STYLES OR SPECIALLY FORMED AND FABRICATED









=a SOLUTION

TO DIFFICULT HEAT TRANSFER PROBLEMS

Now you can apply the engineering, installation, operational and maintenance advantages of PLATECOIL to more tank and process heating and cooling problems than ever before. Standard units with exclusive "MULTI-ZONE" pass design for faster heat-up and temperature recovery or serpentine pass arrangement satisfy many requirements. These "standard" styles, available in a wide variety of sizes can be factory-fabricated into banks to fit the application. PLATECOIL can be formed and rolled to specified diameters or even fabricated to form tank walls.

PLATECOIL provides a "packaged" answer to many heat transfer problems, avoiding costly engineering and fabricating of pipe coils. Units are easy to install and maintain—with simple connections, light weight, and streamlined surfaces. High heat transfer capacity permits compact, space-saving units.

Both "standard" and specially built PLATECOIL are available in mild steel, stainless steel, Inconel, Monel, Ni-O-nel, Hastelloy B, C and F, Nickel and other weldable materials. Operating pressures up to 250 psig. Safety factor—5 to 1. Double embossed or one side flat. Complete engineering data and assistance available.

"PLATECOIL" CAN BE FURNISHED TO COMPLY WITH ASME CODE

Ask for Bulletin P61.

Tranter Manufacturing, Inc.

LANSING 9, MICHIGAN

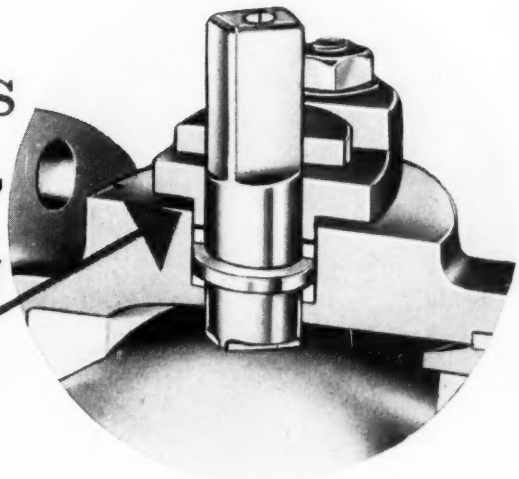
PLATECOIL® DIVISION

FACTS You Should Know About

jamesbury "Double-Seal"™ BALL VALVES*

*PATENTED

Due to jamesbury's unique design, the STEM ASSEMBLY is dependably leak-free



Even if you take the stem out entirely, the Jamesbury "Double-Seal" Ball Valve won't leak. That's due to the valve's superior design, which isolates the stem from the fluid stream. In fact, it is never necessary to remove the valve from the line to replace the stem seals, when this is occasionally needed.

The stem can be removed from the valve under pressure with the valve in full closed position with no leakage occurring.

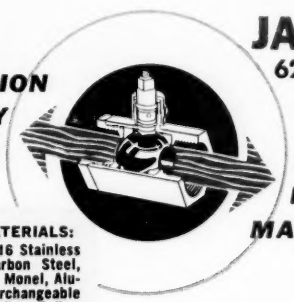
In other ways, as well, the Jamesbury "Double-Seal" Valve is outstanding. For example, there's the Jamesbury patented lip seal which maintains its tight closure despite temperature, pressure or wear. Then, too, the Jamesbury Valve is of unit body construction which means no body joints. Also, when you choose remote operators, these are mounted integral with the valve – assembled and pretested at the factory along with the valve before shipment.

Want more facts? Contact your nearest stocking distributor, or write us direct.

Send for JAMESBURY Fluid Services Guide

JAMESBURY CORP.
62 New Street, Worcester, Mass.
DISTRIBUTORS IN PRINCIPAL CITIES

QUARTER TURN OPERATION
HIGH FLOW CAPACITY
ZERO LEAKAGE



NO LUBRICATION REQUIRED
MINIMUM MAINTENANCE
MANUAL OR POWER OPERATION

WIDE RANGE OF SIZES:

Screwed end ¼" through 3".

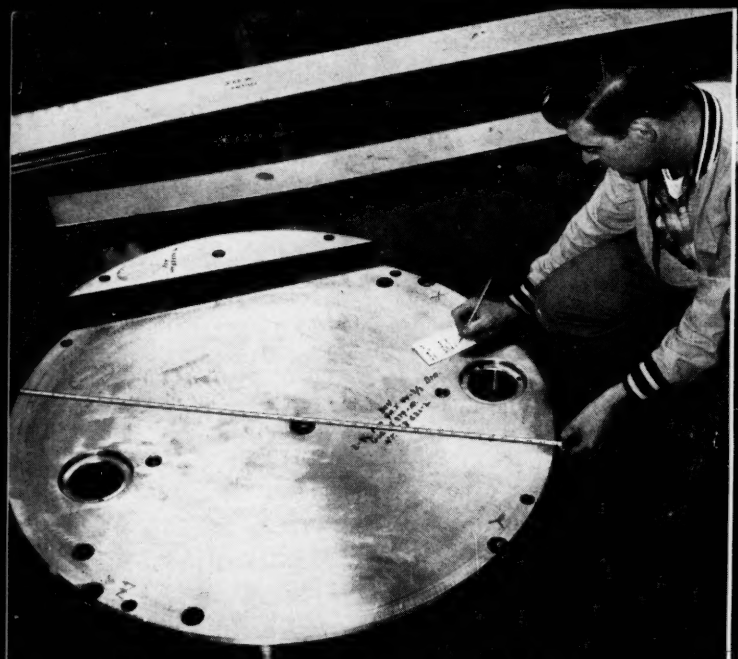
Flanged 150# series ½" through 12" — 300# ½" through 8".

Larger sizes on request.

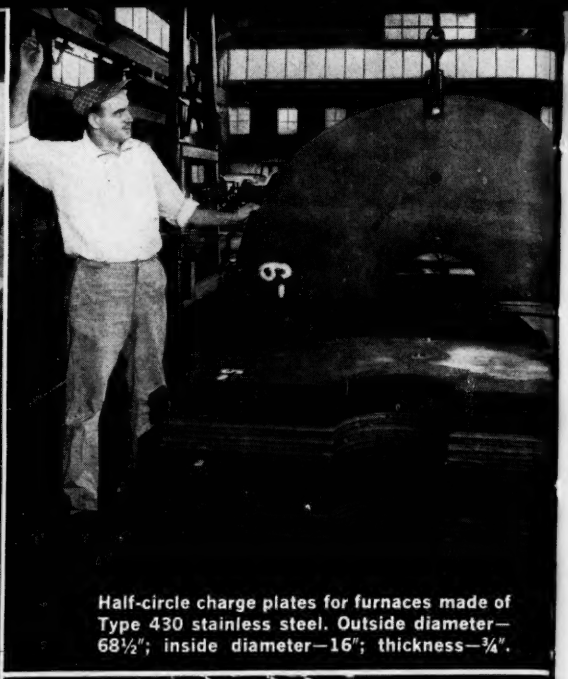
VARIETY OF MATERIALS:

Valves in 303 and 316 Stainless Steel, Alloy 20, Carbon Steel, Bronze, Ductile Iron, Monel, Aluminum and PVC. Interchangeable seats and seals in Teflon, Teflon compounds, Nylon, Buna-N, Neoprene, Hypalon and natural rubbers.

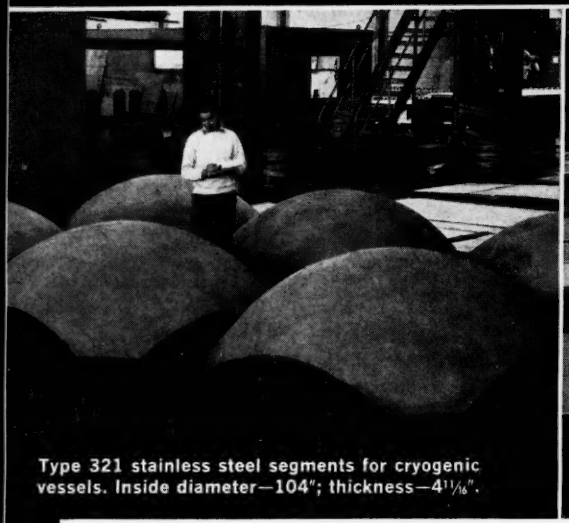
As Versatile As Industry Itself!



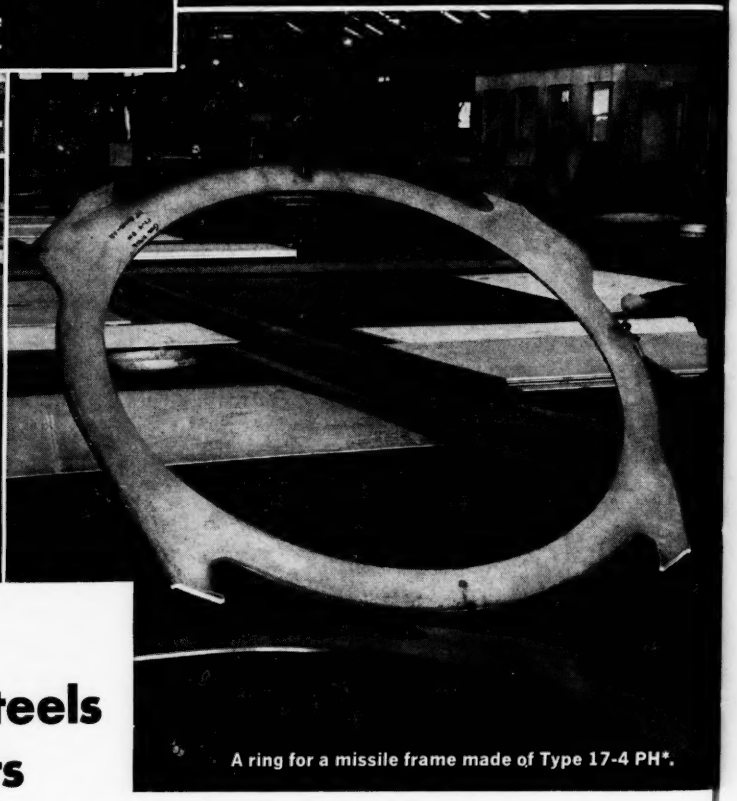
Indexing plate for nuclear storage cask. Type 304. Outside diameter—44⅜"; thickness—2¾".



Half-circle charge plates for furnaces made of Type 430 stainless steel. Outside diameter—68½"; inside diameter—16"; thickness—¾".



Type 321 stainless steel segments for cryogenic vessels. Inside diameter—104"; thickness—4$^{11}/_{16}$".



A ring for a missile frame made of Type 17-4 PH*.

special shapes special stainless steels for special projects

Producing stainless steel plate, plate products, and forgings is our business. Orders often call for unusual shapes in stainless plate, shapes that will become important components in special projects. Whatever the requirement, your confidence in Carlson specialists is well placed.

A Carlson booklet, "Producing Stainless Steels . . . Exclusively," is now available. Why not write for your personal copy today?

*(trade-mark of ARMCO STEEL CORPORATION)

G.O.CARLSON Inc.

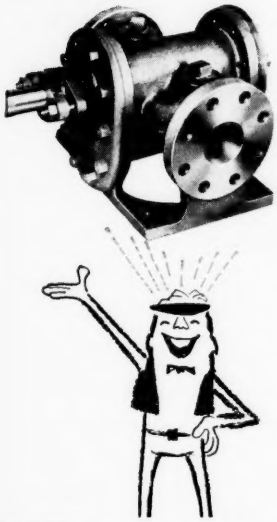
Producers of Stainless Steel

134 Marshallton Road
THORNDALE, PENNSYLVANIA
District Sales Offices in Principal Cities

Plates • Plate Products • Heads • Rings • Circles • Flanges • Forgings • Bars and Sheets (No. 1 Finish)

SK Gear Pumps

HANDLE MANY MATERIALS



Engineers in all types of plants are using SK Gear Pumps to handle materials ranging from kerosene to glue. Time after time these pumps have replaced other types in critical applications. In case after case they have solved costly maintenance or poor performance problems. And, what they have done for others they can also do for you. Why not tell us about your application. We'll be glad to help.

For details—ask for Bulletin G-1

FIT STEAM PRESSURES TO YOUR NEEDS

economically

with SK

JET COMPRESSORS

Convert plant steam pressure to meet varying demand, simply and at low cost, with a SK Jet Compressor.

A jet compressor can be employed to replace a reducing valve and simultaneously produce useful work, by using high pressure steam to entrain and boost low pressure or waste steam to a usable pressure.

For details—ask for Bulletin 4F.

HEAT AND AGITATE LIQUIDS

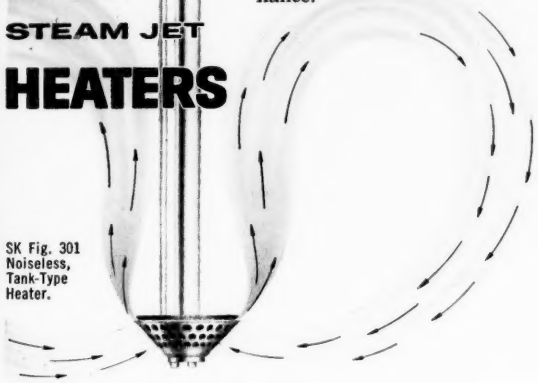
Simultaneously

with SK

STEAM JET

HEATERS

Your plant steam can be utilized economically to heat and agitate liquids in tanks or in pipelines. Through the use of a SK Steam Jet Heater, steam can be mixed with cold liquids to provide heat uniformly, quietly, and efficiently, and to prevent settling. Most types have no moving parts and therefore require absolutely no maintenance.



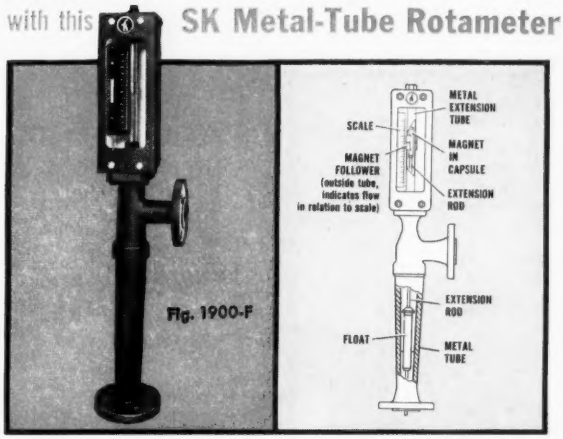
SK Fig. 301 Noiseless, Tank-Type Heater.

For details—ask for Bulletin 3A.

Measure Rate-of-Flow of

HARD-TO-HANDLE FLUIDS

with this SK Metal-Tube Rotameter



SK Metal-Tube (Armored) Rotameters are designed for measuring the rate-of-flow of hazardous fluids, high pressure fluids, and steam. Their accuracy, sound design, and sturdy construction make these instruments easy to apply and easy to use in direct and remote indicating, recording and controlling installations.

For details—ask for Bulletin 19A.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin G-1.

Schutte and Koerting

COMPANY

MANUFACTURING ENGINEERS SINCE 1878

2217 State Road, Cornwells Heights, Bucks County, Pa.

Phone: MErcury 9-0900 TWX: Cornwells, Pa. 69-U

Announcing

A TECHNICAL CONFERENCE

To be held under the joint sponsorship of Ar

Busy with day-to-day responsibilities and continuing pressures to meet work commitments, chemical engineers often find that advances in many fields of chemistry, not directly affecting their present job, have outdated much of their knowledge. Despite resolutions to remedy this lack, the absence of a convenient source of such information and the pressure of priority matters keeps them from following through on this resolve.

Particularly, for such men, a two-day conference on "New Trends in Chemistry" will be held in Chicago on October 11 and 12 under the joint sponsorship of Armour Research Foundation and CHEMICAL ENGINEERING. The technical program will consist of thirteen papers, covering such topics as plasma chemistry, solid-state chemistry, nonaqueous chemistry, kinetics, catalysis, inorganic polymers and radiation chemistry.

While the papers will all be given by experts, they will not be aimed at others in the same specialty but will be pitched primarily at chemical engineers who have been out of college for five or more years. Subjects will be explored in both breadth and depth. Importantly, conferees will have ample opportunity for relaxed, informal discussions.

The conference will be patterned on the highly successful "Conference on the New Chemical Engineering," which CHEMICAL ENGINEERING co-sponsored with Midwest Research Institute in Kansas City last November. It will, however, incorporate improvements suggested as a result of that first conference.

Keynote speaker will be John Turkevich, professor of chemistry at Princeton and State Department adviser on Russian technology. The banquet speaker will be General J. B. Medaris, who was formerly in charge of the Army's missile program and who has been a perceptive critic of our defense efforts. General Medaris is now president of Lionel Corp.

The $50 fee for this important and timely conference covers attendance at four technical sessions, two luncheons, a cocktail party, and a banquet. Registrants will also be supplied with a copy of each of the papers to be presented. For registration and hotel details, write T. R. Olive, CHEMICAL ENGINEERING, McGraw-Hill, New York 36, New York.

NCON NEW TRENDS IN CHEMISTRY

nsors: Armour Research Foundation and Chemical Engineering

October 11 and 12, 1961 Sheraton-Chicago Hotel, Chicago, Illinois

Program for the Conference

Morning Session, Oct. 11, 1961

Keynote Speaker
John Turkevich, Princeton University

Plasma and High-Temperature Chemistry
John L. Margrave, University of Wisconsin

High-Pressure Chemistry
Robert H. Wentorf, Jr., General Electric Co.

Afternoon Session, Oct. 11, 1961

Solid-State Chemistry
F. Schossberger, Armour Research Foundation

Inorganic Complexes
Arthur E. Martell, Illinois Institute of Technology

Nonaqueous Chemistry
Joseph J. Katz, Argonne National Laboratories

Evening, Oct. 11, 1961

Banquet Speaker

General John B. Medaris
Lionel Corp.

Simultaneous Morning Sessions, Oct. 12, 1961

Morning Session 1

Chemical Kinetics
Martin Kilpatrick, Argonne National Laboratories

Chemical Thermodynamics
Ralph J. Tykodi, Illinois Institute of Technology

Catalysis
Vladimir Haensel, Universal Oil Products

Morning Session 2

Inorganic Polymers
Gerhardt Barth-Wehrenalp, Pennsalt Chemicals Corp.

High Polymers
H. F. Mark and S. M. Atlas, Polytechnic Institute of Brooklyn

Organic Semiconductors
Herbert A. Pohl, Princeton University

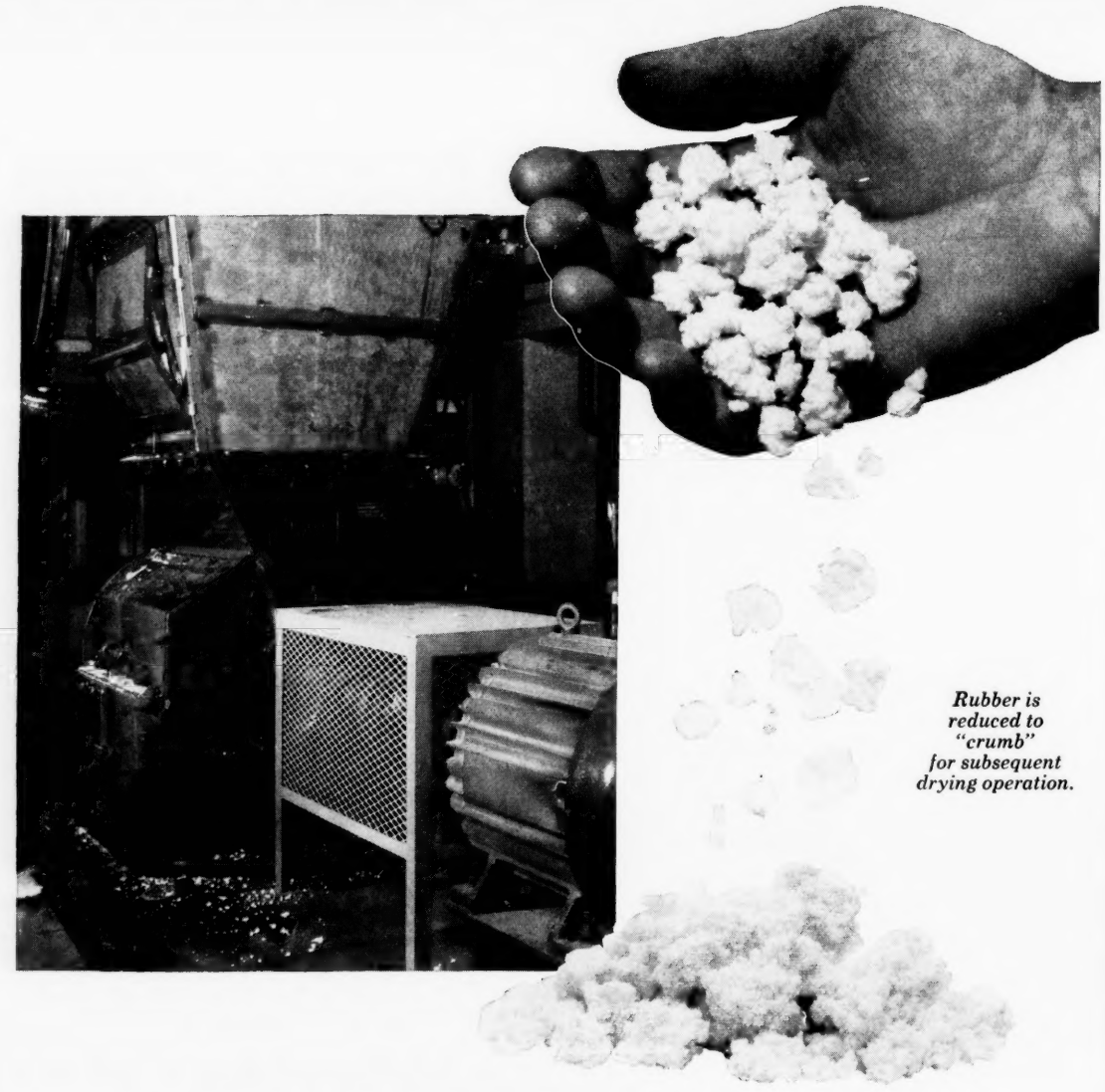
Luncheon, Oct. 12, 1961

Russian Technology
John Turkevich

Afternoon Session, Oct. 12, 1961

Radiation Chemistry
Paul Y. Fang, Armour Research Foundation

Ion-Exchange Resins and Membranes
Harry P. Gregor, Polytechnic Institute of Brooklyn



Rubber is reduced to "crumb" for subsequent drying operation.

JEFFREY DISINTEGRATORS

save time in processing rubber

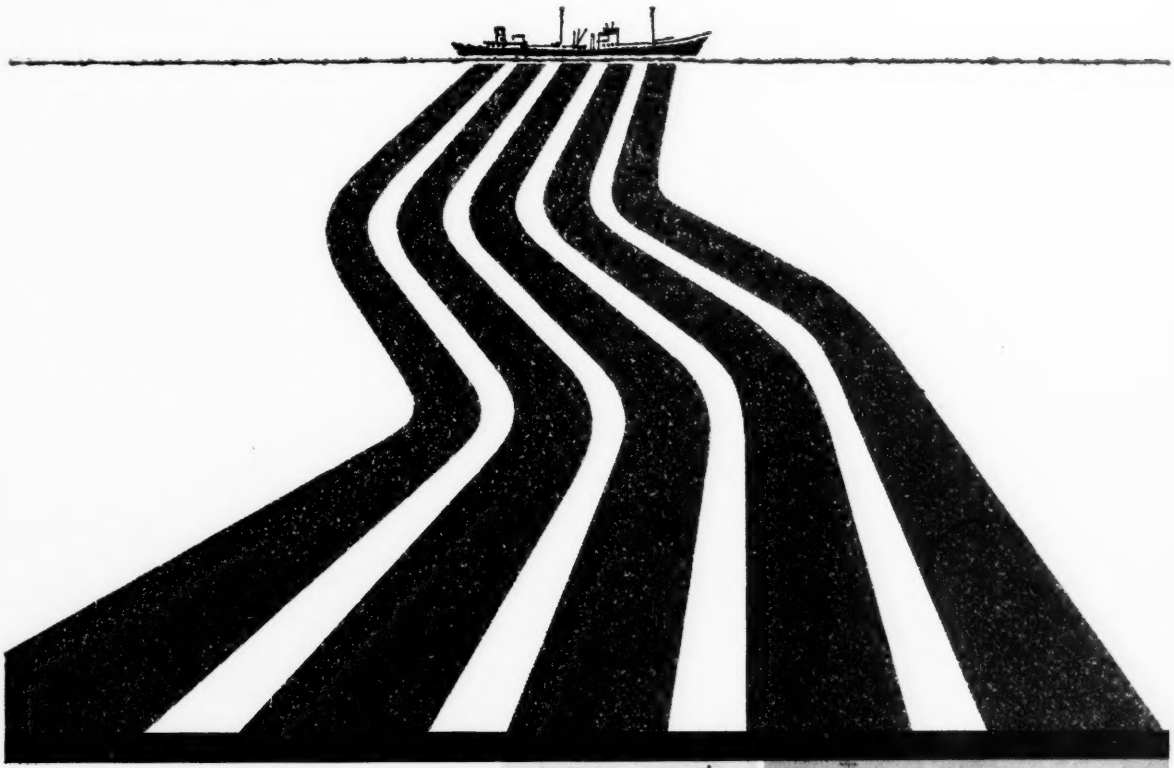
Jeffrey disintegrators quickly rip and tear slabs of wet synthetic rubber into small sized chunks for efficient drying and melting.

The disintegrators shred rubber slabs to "crumb" size of minus 2" to plus ¼" in one operation. These Jeffrey units have an excellent service record with low maintenance demands.

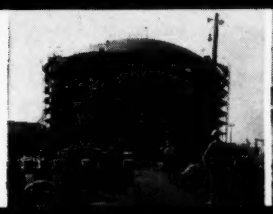
Jeffrey machines can reduce a wide range of materials, whether soft or hard, to the size you want. The Jeffrey Manufacturing Company, 909 North Fourth Street, Columbus 16, Ohio.

JEFFREY

If it's conveyed, processed or mined, it's a job for Jeffrey.



FOAMGLAS® Insulation works for ARABIAN AMERICAN OIL COMPANY



The world's first plant specifically designed to make refrigerated liquefied petroleum gas available for tanker shipment is being built by the Arabian American Oil Company in Ras Tanura, Saudi Arabia. Moistureproof, incombustible FOAMGLAS insulation manufactured by Pittsburgh Corning plays a vital role in this $7-million facility.

Butane, propane or a blend of the two will be produced at the rate of 4,000 barrels per day. This refrigerated processing in climatic temperatures that reach 120°F. puts tough demands on the insulation. FOAMGLAS, a cellular glass insulation, works best.

For example: steel tanks 108 feet in diameter and 49 feet high must store liquefied propane gas at —43°F. FOAMGLAS insulates these tanks from top to bottom to maintain this temperature; piping that contains compressed gas is overcoated with FOAMGLAS; equipment that must be kept completely moisture and vapor free is protected with FOAMGLAS.

Write for our Industrial Insulation Catalog. Pittsburgh Corning Corp., Dept. H-91, One Gateway Center, Pittsburgh 22, Pa. In Canada: 3333 Cavendish Blvd., Montreal, Quebec. For specifications and local offices, see our Chemical Engineering Catalog insert, pages 1495-1498.

PITTSBURGH
PC
CORNING

How to keep your pump out of your product

When all surfaces that touch pumpage are *glass*—your pump stays out of your product.

That's the way it is with the Goulds-Pfaudler pump. Sturdy borosilicate glass, permanently fused to metal, ends product contamination, discoloration and corrosion.

Glass is *smooth*. It discourages product adhesion and scale build-up.

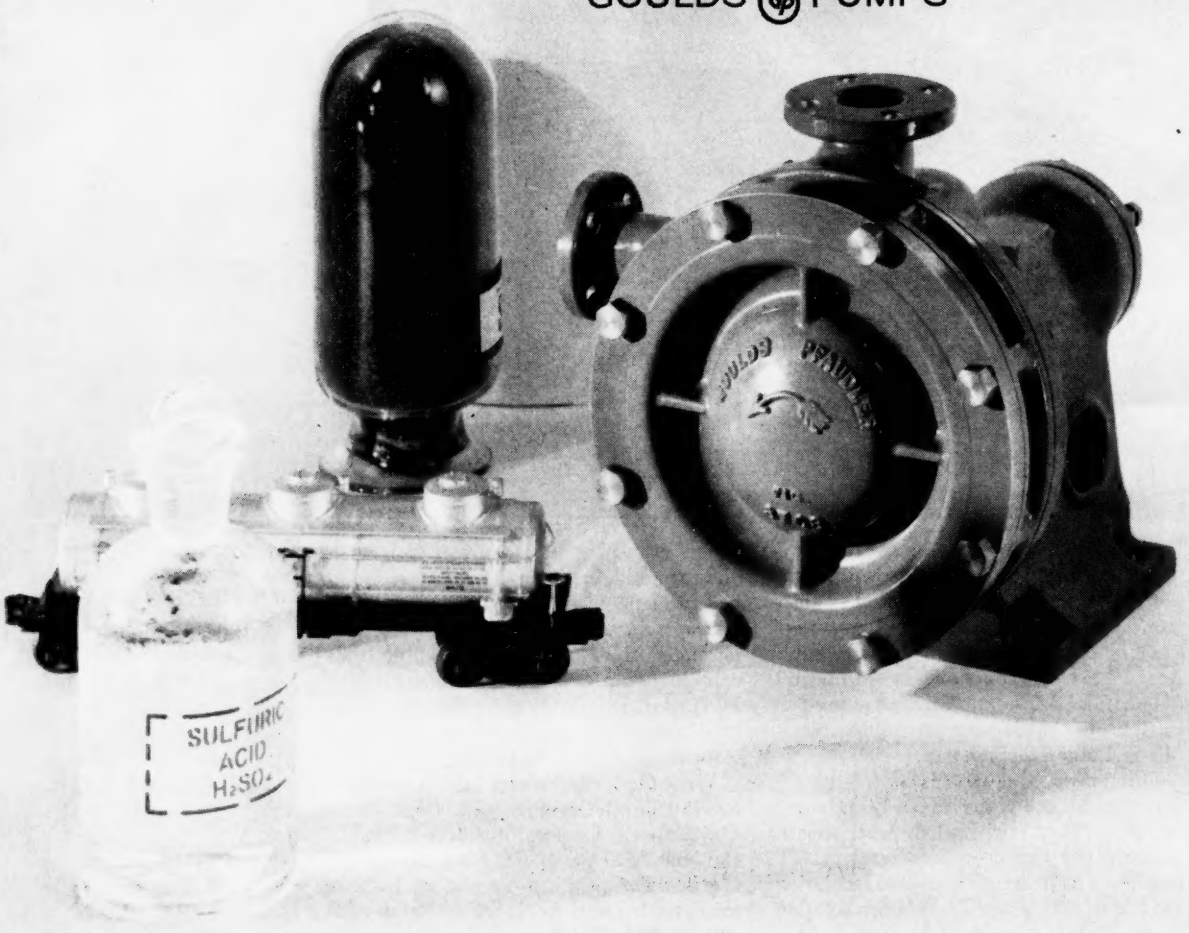
The Goulds-Pfaudler pump makes other tough pumping problems easier, too. Its glass-to-metal bond resists all but hydrofluoric acids at temperatures up to 350°F. and alkalies at moderate temperatures.

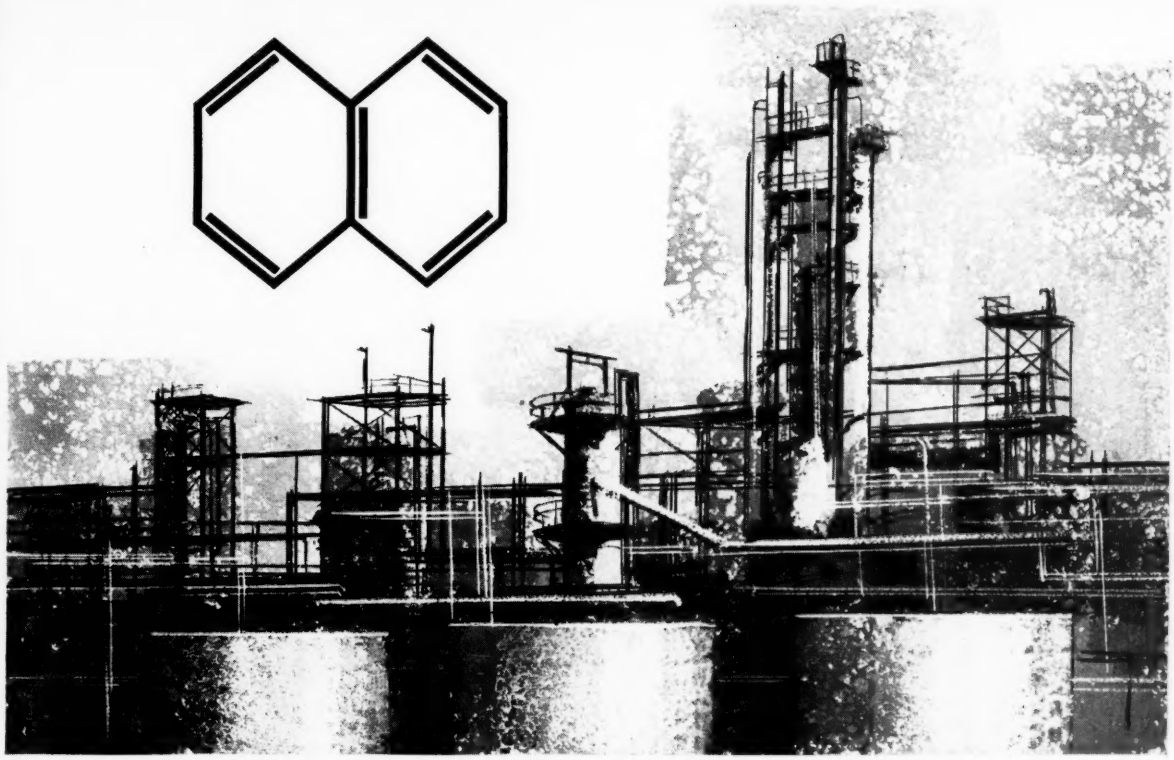
You can get the Goulds-Pfaudler glassed pump in conventional hydraulic design, capacities up to 700 GPM, heads up to 140 ft.

For full details, write for Bulletin 725.2 plus a second booklet, "It's What's Inside That Counts," which gives you the story behind this pump.

Goulds Pumps, Inc., Dept. C-3, Seneca Falls, New York.

GOULDS PUMPS





ENRICH NAPHTHALENE FEED STOCK WITH QO® FURFURAL

A high concentration of naphthalene precursors in the feed stock of a hydrodealkylation unit is desirable. A good way to obtain this maximum concentration is to separate the aromatic compounds from the feed stock by the use of furfural. An enriched feed stock will not only boost naphthalene production, but will also cut hydrogen consumption.

Furfural is a polar molecule and gives excellent separation of saturates from unsaturates in lube oils, gas oils, cycle stocks and naphthalene feed stocks. It is also effective in the separation of organic sulfur compounds or heavy metal complexes from petroleum fractions.

Furfural offers dual economy in its low price plus operational savings. In lube refining over 99.95% of the circulated furfural is recovered; the high thermal stability of furfural permits long continuous operation between turnarounds.

Begin your investigation of the use of furfural to enrich your naphthalene feed stock by writing for Bulletin 203-A, "Physical Data On QO Furfural."

The Quaker Oats Company

CHEMICALS DIVISION

The Quaker Oats Company — CHEMICALS DIVISION — QO — CHEMICALS

335Y The Merchandise Mart,
Chicago 54, Illinois

Room 535Y, 120 Wall St.,
New York 5, N. Y.

Room 435Y, 49 S.E. Clay Street
Portland 14, Oregon

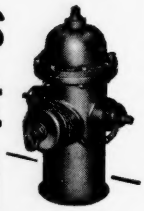
In the United Kingdom:
Imperial Chemical Industries, Ltd., London, England

In Europe:
Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France;
Imperial Chemical Industries (Holland) N.V., Rotterdam, Holland
Imperial Chemical Industries (Export) Ltd., Frankfurt a.M., Germany

In Australia:
Swift & Company, Ltd., Sydney

In Japan:
F. Kanematsu & Company, Ltd., Tokyo

Darling B-50-B Hydrants are built for exceptional service



YOU CAN DEPEND ON

DaRLing

Packless "O" ring seals (1) cut friction while assuring complete, permanent lubrication of operating mechanism. Ball bearings (2) reduce operating torque up to 50%. Direct-acting rod (3) operates the main valve and drain valve without auxiliary components.

An extra large barrel (4) delivers water at the nozzles without appreciable pressure loss. Multi-port draining (5) with positive flushing makes stoppage or freeze-ups virtually impossible . . . *you can depend on Darling.*

Darling B-50-B Hydrants are available in types and sizes for practically every installation. Write for Bulletin 5710.

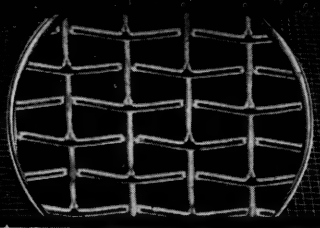
DARLING VALVE & MANUFACTURING COMPANY
Williamsport 3, Pa.

The Canada Valve & Hydrant Co., Ltd., Brantford 7, Ontario, Canada
Vannes Darling-France, 23 rue du Commandant Mouchotte, St. Mandé, France

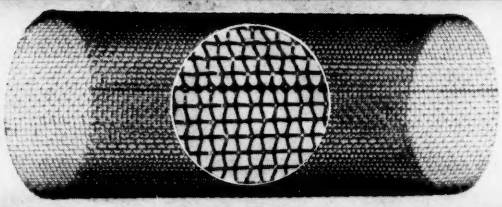
GATE • BUTTERFLY • CHECK • SPECIAL VALVES • FIRE HYDRANTS

Need Wire Cloth Specials? Call *Cambridge*

BRAZED

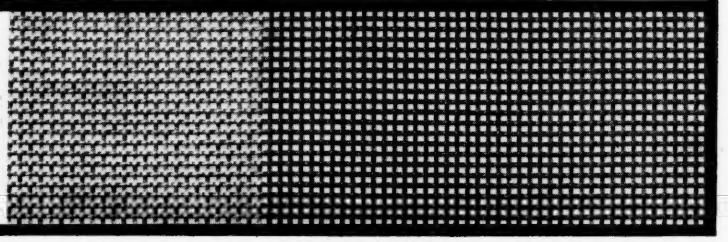


SEAMLESS



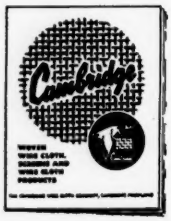
TEFLON* COATED

Right Side Coated



*Reg. T.M. of DuPont Company

These are just 3 of the many wire cloth specialties Cambridge can produce for you—no matter how large or small a quantity you need. Or, if you have an extra-special problem, there's an expert on hand to discuss your special needs . . . your Cambridge Field Engineer. He can show you how to get the results you want—in the quickest possible time at the lowest possible cost.



Your Cambridge Field Engineer is listed in the Yellow Pages under "Wire Cloth." Call on him at any time. Or, write for illustrated, 120-page catalog.

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Refer to our technical data sheets in CHEMICAL ENGINEERING CATALOG, Page 185

VISIT US AT THE CHEMICAL EXPOSITION IN NEW YORK—BOOTH 1423

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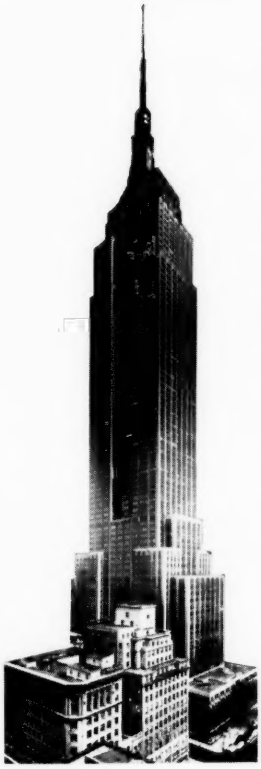
Manufacturers of Metal-Mesh Conveyor Belts, Flat Wire Conveyor Belts, Wire Cloth, Wire Cloth Fabrications and Gripper® Metal-Mesh Slings.



How Empire State Building and American Airlines solved vital fire protection problems with EVERLASTING VALVES

102 stories, 1,472 feet high, 16,000 tenants and 35,000 visitors sum up the fire protection problem of the Empire State Building. An in-building fire protection system is necessary to an unfailing water supply.

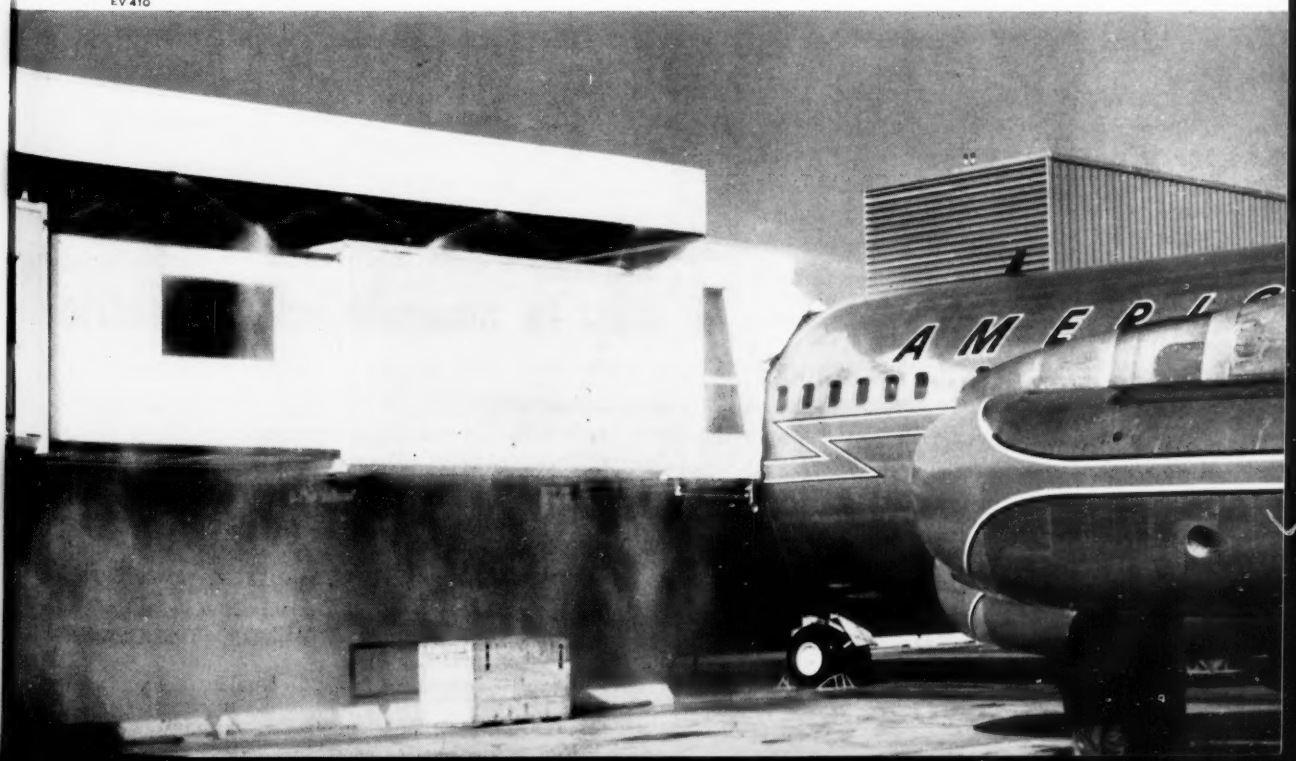
American Airlines loading bridge, shown below, gives passengers positive protection against fire with a unique deluge system.

Both these fire protection systems depend on Everlasting Pendulum Stop Valves, which have been installed in thousands of critical fire protection systems over the past 35 years.

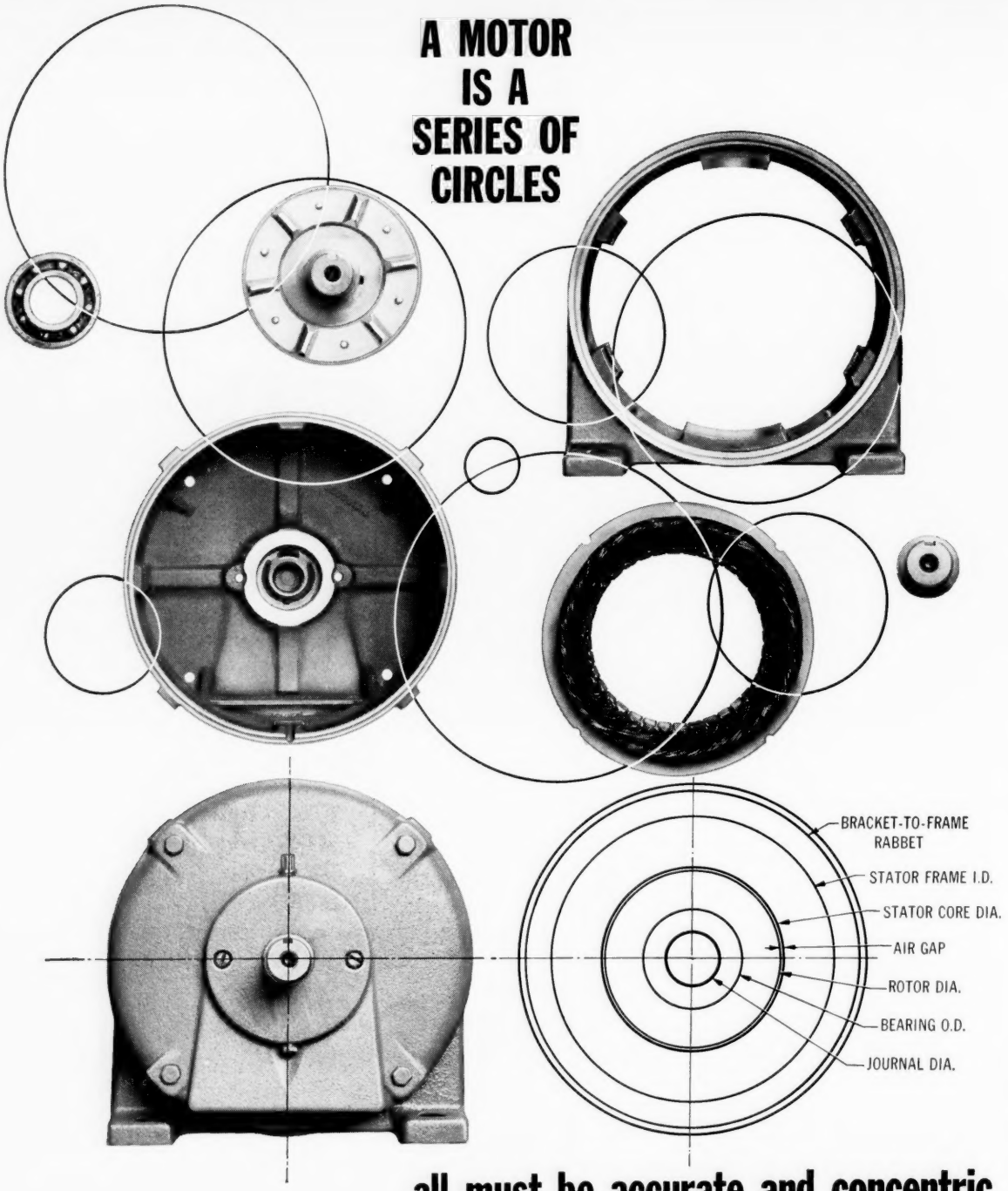
For complete information on the unique American Airlines and Empire State Building systems, write for bulletins F. They include an editorial description of both these installations and a bulletin describing Everlasting's positive action pendulum stop valves.

Everlasting also makes a line of quick-opening valves for general service, boiler blow-off, and handling viscous materials, as well as a line of cylinder-operated valves. Bulletins on all these valves are available. **Everlasting Valve Company, 78 Fisk Street, Jersey City 5, New Jersey.**

EV 410



A MOTOR IS A SERIES OF CIRCLES



all must be accurate and concentric

In manufacturing Elliott Crocker-Wheeler motors, a dozen critical "circles" are formed accurately and concentrically through unique and extraordinarily precise production methods. The result is exact alignment of all parts, true and uniform air gap, free-spinning rotor, quiet, cool, dependable operation.

■ *Elliott Crocker-Wheeler integral-hp a-c and d-c motors—from smallest to largest—are offered in all conventional enclosures and modifications; with insulation to suit the application, including* EPA SEAL *epoxy insulation for use where conditions are most severe.* WI-3

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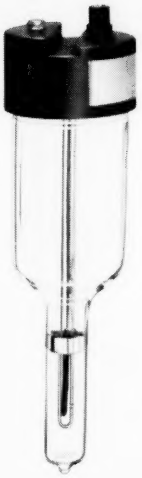

...with new rugged 7" reference and 3¾" glass electrodes...

new industrial pH system stresses reliability, flexibility

Beckman, world leader in pH instrumentation, introduces the all-new Model J pH System: compact transistorized analyzer, short, rugged electrodes, and accessory mounting assemblies. Here's continuous analysis equipment which provides reliability, flexibility, and convenience never before possible in industrial applications.

Check these Model J features, then see your Beckman Sales Engineer or Recorder Company Salesman for complete details, or write for Data File 14-36-06.

READOUT FLEXIBILITY. Available with both ma and mv output for use with any potentiometric or current recorders and controllers–or, with mv output only–recorder scale may be expanded to any 2 pH span full-scale. High or low alarm feature may be added.

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HOW TO MAKE A MOUNTAIN OUT OF A MOLECULE

Molecules are tiny things, but the magic molecules of Sinclair petrochemicals grow like crazy when you use them as "building-blocks." In your hands, they can become a mountain of fast-selling items that mean extra profits to you.

For example, in the plastics and synthetic fibres industries Sinclair petrochemicals are indispensable raw materials being used in the development of countless new and exciting products. Even when you add the new developments in paints, fertilizers, insecticides and detergents, you've only scratched the surface of profitable opportunities.

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Top news stories and what they mean to CPI technical decision-makers

Chementator

West Coast phthalic plant will be first to use German process

Allied Chemical Corp. will go ahead with construction of its proposed phthalic anhydride plant at El Segundo, Calif., using the Von Heyden-Chemiebau fixed-bed process. Ralph M. Parsons Co., Los Angeles, will build the plant, scheduled for operation late next year.

Presently used in Japan, Argentina, Soviet Union and Germany, the process usually employs naphthalene as a feed material, although Allied selected the route because "it can utilize a variety of raw materials." Presumably, this includes *o*-xylene, adding spice to the already-hot *o*-xylene-vs.-naphthalene competition for the phthalic feedstock business (*Chementator*, July 10, p. 62).

Despite a world production of "many thousands of tons/yr.," all that is known about the Von Heyden process is that it employs the usual poisoned vanadium pentoxide catalyst and is said to give a high phthalic yield from feed naphthalene. Oxidation is achieved with atmospheric oxygen.

Another new phthalic plant will be built by the Oronite Div. of California Chemical Co., at Perth Amboy, N. J. It will be Oronite's (and the U. S.'s) second fixed-bed phthalic plant built to use *o*-xylene for feedstock.

Unexpected corrosion shuts down Texas sea water conversion plant

Office of Saline Water's sea water conversion unit at Freeport, Tex., has been shut down for repairs —to the surprise of both the builder, Chicago Bridge & Iron Co., and the operating contractor, Stearns-Roger Mfg. Co., Denver.

Statements from both Stearns-Roger and OSW indicate that the problem is minor; but the plant, out of operation for almost four weeks, won't go back on stream until sometime this month.

Salt water contamination of the product stream was traced to corrosion in heat exchangers that use waste heat from the product water to warm the incoming raw salt water.

Even though the long-tube-vertical evaporation plant was designed to evaluate corrosion effects on a variety of construction materials, the current problem came from an unexpected quarter. Hundreds of carbon-steel plugs, blocking unused openings in exchanger tube sheets, were preferentially destroyed by galvanic corrosion between the plugs and metal-alloy tubes. CB&I engineers reasoned that using plugs made of the same metal as the tube sheet would minimize corrosion. Now, however, crews are laboring to replace these plugs with others made of materials similar to that in the tubes.

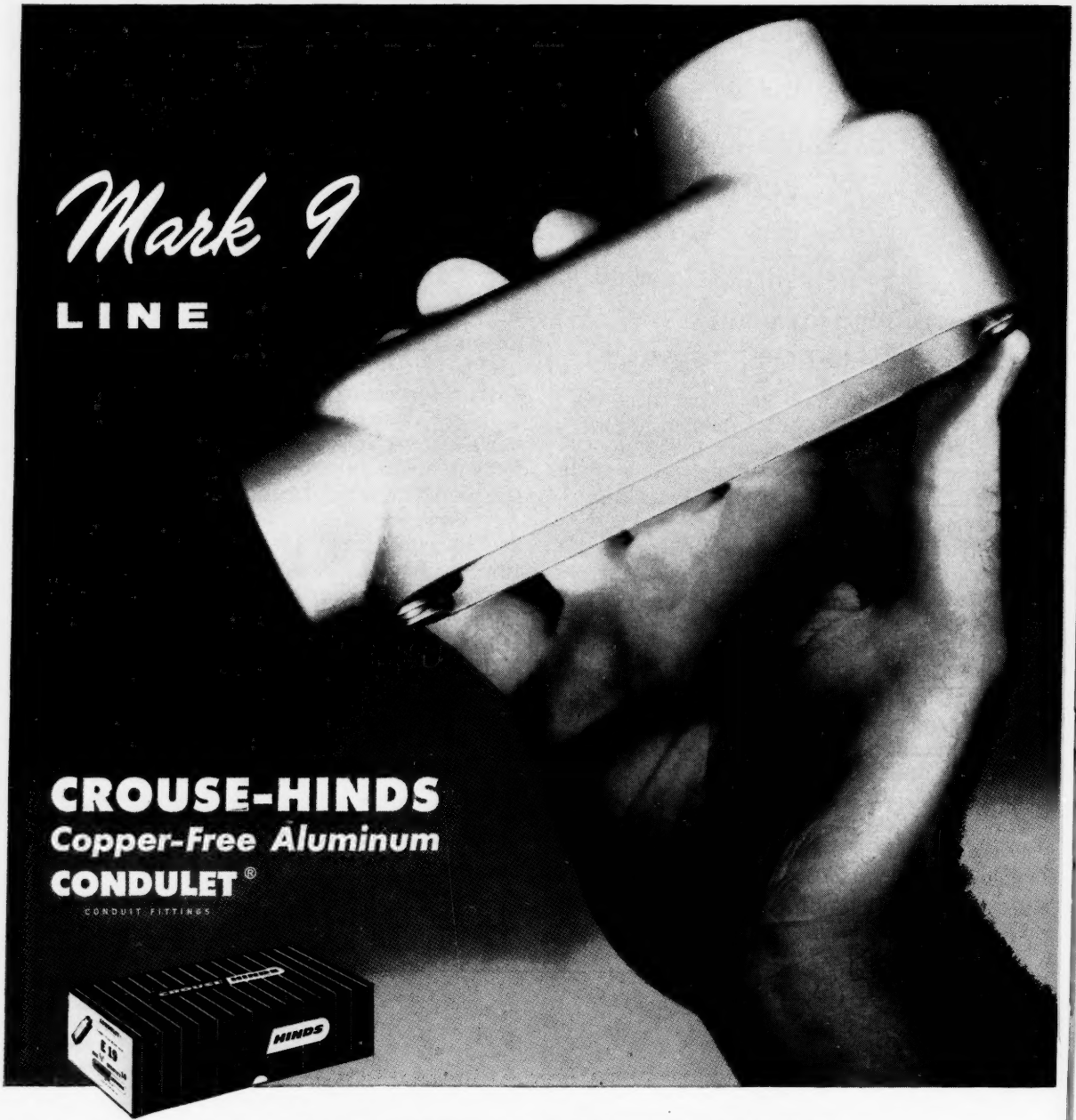
A cursory inspection indicates that Admiralty-metal tubes have withstood salt water corrosion better than other tube metals—aluminum-brass, 90/10 copper-nickel, carbon steel. But decisions on which materials to use in future installations are being withheld, pending more thorough investigation.

Potash center shifting northward following latest capacity hikes

By 1963, more potash will be coming from Utah and Canada than from the traditional heartland of the industry around Carlsbad, N. M.

The magnet: rich deposits of 30% ore, and a capacity gap resulting from the industry's failure in recent years to keep pace with a consumption that's risen about 6% per year in the U. S. and 6-10% per year abroad.

In the latest move, International Minerals & Chemical Corp., Skokie, Ill., has just boosted estimated capacity of its long-projected operation at Saskatchewan, Can., from 420,000 tons/yr. to 1.2 million. Earlier this year, Texas Gulf Sulphur announced plans to install well over 1 million tons/yr. of new potash capacity in the Moab, Utah, area. Both expect to start up late in 1962. Still further ahead in the future is the possibility



From Crouse-Hinds, originator and leading manufacturer of electrical conduit fittings, comes the new "Mark 9" line. Die-cast, copper-free aluminum. The ultimate in protection, and ease of installation. Compare with any other die-cast conduit fitting—and you'll choose no other.

Smooth and lightweight with the trim good looks that die-casting imparts.

More wiring room inside is provided by new cover-opening. Compare with others and see.

Rugged and corrosion-resistant because it's die-cast of copper-free aluminum, resistant to corrosion.

Easy to install, with self-retaining cover screws, smooth integral bushing, taper-tapped threads, longer grip-sure hubs.

Full range of types and sizes, from ½" to 4".

Complete selection of wiring devices.

Neoprene gaskets for greater resistance to oil and chemicals; with perforated tear-out centers where open gaskets are needed for wiring devices.

UL-listed; CSA-approved, made to Crouse-Hinds high standards of quality and inspection.

Competitively priced. Ask your Crouse-Hinds Distributor.

For complete "Mark 9" details, write for Bulletin #2730 or contact your Crouse-Hinds Office.

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of another venture in Utah, based on Continental Oil's disclosure of exploratory drilling activity about 30 miles from the Texas Gulf mine.

In Saskatchewan, other projects may be forthcoming from reserve-owning companies who have been awaiting the outcome of the pioneering efforts by IMC, and Potash Corp. of America, which has experienced difficulty in operating its 320,000-ton/yr. plant.

Chief stumbling block to both companies has been the Blairmore formation, a massive underground swamp about midway between the surface and the deposits located at the 3,500-ft. level. By freezing the quicksand and sinking a heavy concrete shaft, Potash Corp. actually started production in 1959. But leaks soon closed the operation. The company is now working on a grouting program. On the other hand, IMC is reported to have pushed its shaft down past the watery stratum.

Meanwhile, a joint venture of Armour Co. and Pittsburgh Plate Glass Co. will attempt to take advantage of the water in the Blairmore stratum by using it for solution mining (*Chem. Eng.*, May 15, p. 72). It is also possible that freight costs can be reduced by pipelining the potash solution to the Great Lakes.

New answers to cryogenic puzzlers broaden ultracold's job prospects

Many questions about how to work with conditions at the lower end of the absolute temperature scale are now being answered. During the 1961 Cryogenic Engineering Conference at the University of Michigan, August 15-17, experts disclosed technical achievements that were typical of a consolidating rather than a pioneering stage of development.

Liquid hydrogen, for example, will be handled in large volumes as the propulsion fluid, during development of a nuclear-powered rocket engine.

To avoid large circumferential temperature gradients that might cause bowing of the system piping during cooldown, Los Alamos engineers use the "Baker diagram." Originally developed for two-phase flow in oil-gas mixtures, this correlation between liquid and gas mass-flow rates provides the cryogenic engineer with a minimum flow specification. Above this limit, there will be no stratified flow to cause large circumferential temperature gradients during evaporation of the hydrogen.

Liquid neon recently became available in quantity, and usage of liquid helium has increased. Linde Co. engineers have designed containers for shipment of commercial quantities of each.

A 15-liter unit holds evaporation loss of neon to 0.3% of capacity per day. Having a boiling point of 27.2 K. and a heat of vaporization of 97.2 Btu./liter, neon requires protection by a liquid nitrogen shield, as well as high vacuum and multilayer super insulation. To contain liquid helium, which boils at 4.2 K. with only 2.4 Btu./liter heat of vaporization, Linde has designed a 100-liter vessel that restricts evaporation to 1.6-1.7% of full capacity per day, using high vacuum, gas shielding and super insulation.

Other developments reported: a monitor to detect freeze-plugging of vent lines that could lead to pressure buildup and rupture of cryogenic storage vessels; O-ring seals for temperatures where elastomers act like crystalline solids; epoxy-nylon adhesives that prove superior to all other commercially available classes from +78 F. to —423 F.

Israeli scientists at the Negev Institute for Arid Zone Research have developed a 250-gal./day demineralizer for creating drinking water from underground saline waters. Based on electrodialysis, unit uses a new kind of membrane. A 500,000-gal./day-unit is ready for testing.

Oil may replace water as carrier for coal in long-distance pipelines

Long-distance transport of coal in a pipeline, hitherto accomplished only by pumping a coal-water slurry (Consolidation Coal Co.'s 105-mi. Ohio line), may become feasible using oil as the carrying medium.

Pilot-plant tests by the Research Council of Alberta have demonstrated in a 1-in.-dia. line that a 16 x 48-mesh coal fraction at slurry concentrations up to about 35% does not measurably alter the flow patterns and pressure gradients found with oil alone. Furthermore, concentrations as high as 70% can be moved at normal pipeline velocities without any settling in the line.

Field trials will be conducted next year in

(Continued on page 58)

AT LAKESIDE LABORATORIES, IN
P-K VACUUM TUMBLE DRYER IN
PRODUCT UNIFORMITY...
LOWERS LABOR COSTS...
REDUCES DRYING TI

Lakeside Laboratories, Inc., a Milwaukee manufacturer of ethical pharmaceuticals, has replaced conventional tray drying with a P-K Vacuum Tumble Dryer. The pre-packaged 20 cu.-ft., stainless steel unit arrived fully engineered, ready for start-up. "It had everything we wanted—a hot water jacket vacuum pump, condenser, condensate receiver, vacuum control valve, water heater and circulating pump—and was reasonable in cost," explains Joseph Jacques, plant engineer.

Today, all products Lakeside manufactures in quantity are processed in the P-K unit. "It has made it possible for us to reduce drying time as much as two-thirds and cut labor costs in half," says Mr. Jacques. "It used to take 48 hours to dry a batch of material we're now able to prepare in 16 hours. Handling time is a fraction of what it was and the resultant blend is more uniform in texture and color. Furthermore, moisture content of products can be reduced to as low as 1/10 of 1% in the vacuum tumble dryer.

"Cleaning, too, is faster and easier, thus facilitating formulation change-over without time loss. After each use, the dryer is filled with water, rotated and flushed. There's never any residue and reduced handling also reduces chances for contamination."

ONLY P-K OFFERS COMPLETELY PRE-PACKAGED VACUUM TUMBLE DRYERS Packaged vacuum tumble drying equipment—tailored to individual requirements

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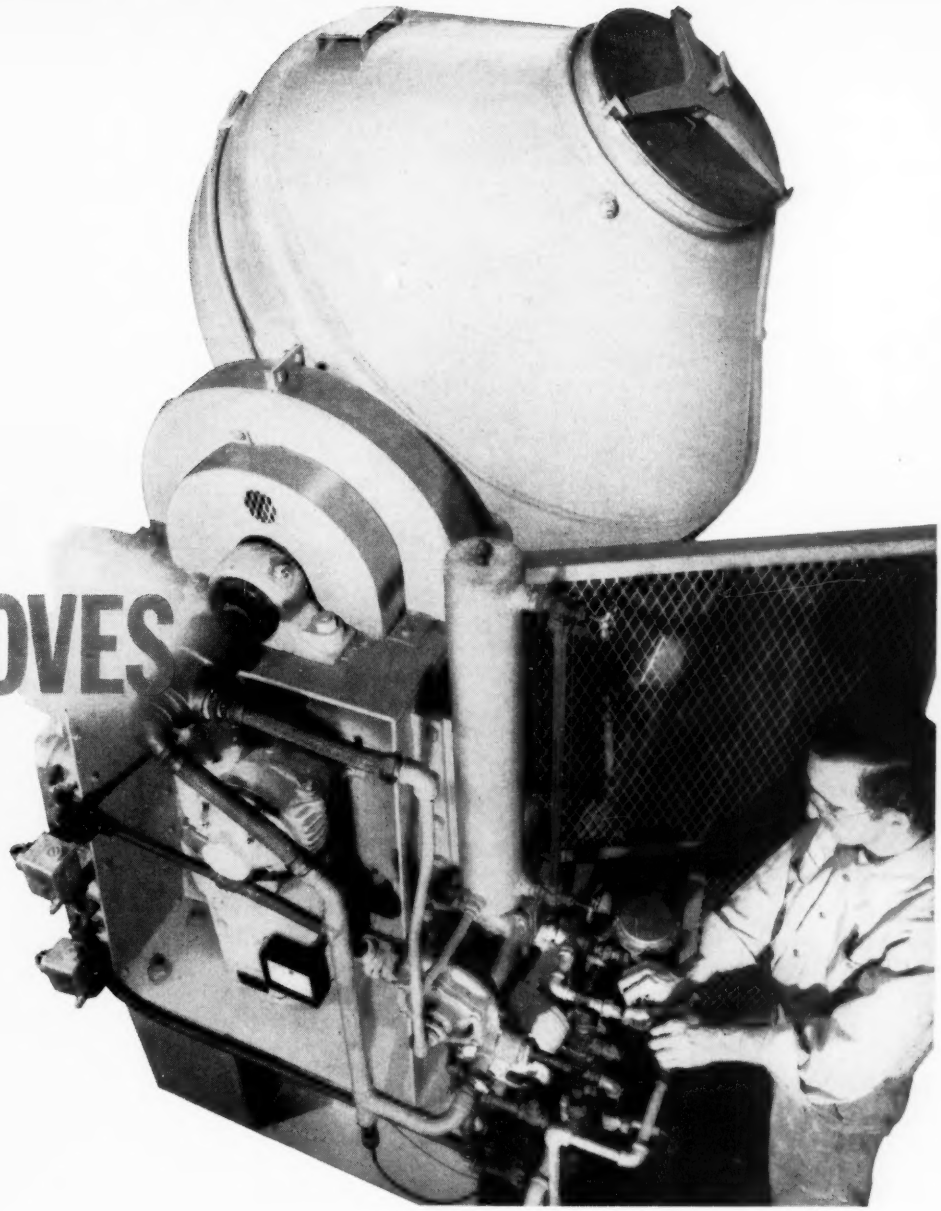


and thoroughly proved in performance—is available only from Patterson-Kelley. It is delivered compactly assembled, fully balanced and ready for use. Yet, costs are far less than user-assembled units. In addition, it provides a single source of responsibility. In every step from design through start-up, it saves time—eliminates trial and error expense.

PRE-TEST BEFORE YOU BUY Visit the P-K PRE-TEST LABORATORY for a preview of the economies *you* can realize with a packaged vacuum tumble dryer. P-K engineers have run thousands of resultful pre-tests for processors. They justify investment, provide accurate scale-up data and operational procedures. Production models of standard, intensifier and liquid-solids Twin-Shell* blenders are available, as well as packaged vacuum tumble dryers. Our new P-K Solids Processor that telescopes up to ten operations in a single unit is also featured in the Pre-test Laboratory.

Send us your materials, if you can't come in person. To make arrangements, write or call George Sweitzer at East Stroudsburg. Dial 717—Hamilton 1-7500.

Our new Solids-Process Catalog #16-P contains complete technical information on P-K equipment. We'll gladly send you a copy.

*patented

Patterson Kelley

Chemical and Process Equipment Division
124 Burson St., East Stroudsburg, Pa.

the Edmonton area. If successful, Western Canadian coal may then be moved to the Ontario market using spare crude capacity in existing oil pipelines. It is estimated that existing lines could carry upwards of 20 million tons of coal per year. Eventually, a coal-oil pipeline may be built to Montreal.

Meanwhile, prospects for another domestic line were heightened when Pennsylvania's state legislature passed a bill granting the right of eminent domain to coal pipelines in that state, over bitter opposition from railroads and anthracite coal producers. The proposed line, originating in W. Va. or western Pa. (*Chementator*, Dec. 12, 1960, p. 74), would furnish powdered coal or a burnable slurry to Eastern utilities.

A 17,000-bbl./day Isocracking unit will be built in the 100,000-bbl./day oil refinery slated for Pascagoula, Miss. A joint effort of Standard Oil Co., Ky., and Standard Oil Co. of Calif., the refinery will obtain crude oil from the Gulf Coast area.

Liquefied gas now seeks major job in refrigerated-transport systems

The expression "bottled gas" soon may become as familiar in refrigeration as it is in home cooking. But it will refer to liquid nitrogen rather than liquefied petroleum gas, and will be applied to use of the nitrogen for refrigeration in the gigantic $41-billion per year refrigerated-products segment of the economy.

Supporting this contention: the Polarstream liquid nitrogen system developed by Linde Co., Div. of Union Carbide Corp., is working well in both local delivery trucks and long-haul trailers. For example, Howell Trucking Co., New York, now operates 16 delivery trucks equipped with this system. And REA Leasing Corp., New York, has completed six long-haul trailer runs carrying fresh meat.

Liquid nitrogen appeals to food transporters because reliability of the gas system surpasses that offered by mechanical refrigeration. Van temperature is more uniform, there is no dehumidifying effect and circulation space is reduced. Consequently, there is less spoilage, no reduction in quality or weight from dehydration and more complete use of space. Absence of spoilage and dehydration has been proved with meat and perishables such as lettuce.

To cool with liquid nitrogen, the Polarstream system uses either a single cylinder containing 280 lb., or four cylinders, each holding 370 lb. On a signal from a thermistor-activated electrical bridge circuit, a solenoid valve releases liquid nitrogen into the cargo space through a single spray pipe overhead. The liquid flashes instantaneously into cold dry gas, absorbing 85 Btu./lb. of liquid evaporated. An additional 80 Btu./lb. is absorbed by the gas as it circulates.

System will control at any temperature level from above freezing down to —320 F., the boiling point of the liquid nitrogen. Cost of cooling is roughly comparable to mechanical refrigeration.

TaC_2 filaments will shine brighter in acid-hydrocarbon-H_2 atmosphere

A new kind of light bulb is in the offing. And tungsten filaments in inert nitrogen-argon atmospheres may become a thing of the past. This is what participants at the 18th International Congress of Pure and Applied Chemistry heard in Montreal three weeks ago.

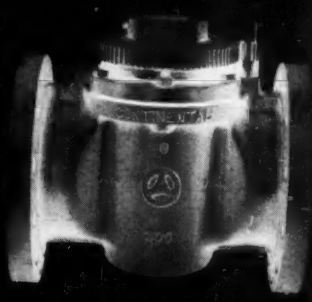
Jointly developed by Polaroid and Union Carbide, the new lamp lasts from 50 to 100% longer than conventional tungsten types and is 25% more brilliant because of a high-melting tantalum carbide filament. According to researchers, a lamp's brightness can be increased only by raising the temperature of the filament, and not by using more power.

Polaroid scientists found that tantalum carbide filaments would decompose when operated in the usual nitrogen-argon atmospheres. Many years of experiment led to a suitable atmosphere of hydrocarbons and hydrogen that prevented the filaments' decomposition, but the high heat-conductivity of these gases would bleed off much of the electrical power fed into tantalum carbide filaments. This second problem was solved by using less hydrogen and adding halogen acids, particularly HCl and HBr.

Ordinary tungsten lamps burn between 5,480 and 5,660 F., tantalum carbide between 5,840 and 6,020 F. The difference in burning temperatures is not great, but it is in this area that small increases in temperature will boost brilliance significantly.

The Lighting Products Div. of Sylvania has been cooperating with Polaroid in making prototype lamps, but no plans have yet been formulated for commercial production. An initial appli-

symbol of modern valve design — Announcing Continental's new 8", 10" and 12" Teflon-sleeved, non-lubricated plug valves. Now, for the first time, Tufline's proven design features ....pre-stressed pure Teflon® sleeve, sculptured body bore, bubble tight performance....can be obtained for larger piping. Advantages: quick, easy operation [manual, automatic], no flow pockets. 150# rated for light gases to heavy slurries and corrosive services. Also available in bottom-entry 3-way design and choice of metals. Write Continental Manufacturing Co., 230 Park Ave., NY 17, NY



TUFLiNE valves

cation would probably be in projectors for slides and films. New auto headlights, stadium lights and flashlight lamps are also under active consideration.

Metallic tungsten and related chemicals will roll out of a facility to be built at Fresno, Calif., by Stearns-Roger Mfg. Co., Denver, for the New Idria Mining & Chemical Co., Idria, Calif. The plant will process high-grade ore as well as domestic and foreign concentrates. New Idria is one of the U.S.'s largest mercury producers.

British development provides novel route to ultrapure nitrogen

British technology has come up with a new process that yields highly pure nitrogen at useful pressures.

Developed by Petrocarbon Developments, Ltd., London, the process raises entering feed air to 110-125 psig., and subsequently yields 99.999% nitrogen at only slightly lower pressure—without intermediate recompression. Product is directly available for distribution and use, eliminating need for downstream compressors that could cause contamination by leaking oil.

Plants in England have been using this route since early 1960. And it is now making its U. S. debut in a unit being built for an undisclosed, large producer of electronic components. Exclusive U. S. license for Petrocarbon's development is held by Superior Air Products Co., Newark, N. J.

Key feature of the process is its thermodynamic cycle: refrigeration is not obtained by conventional expansion of the feed stream, but rather by expanding the nitrogen-depleted by-product stream from fractionation. Fractionation itself takes place at about —270 F.

According to Superior Air Products, the process is available in package plants for capacities ranging from 3,000 to 10,000 std. cu. ft./hr. Based on power at 1¢/kwh., direct operating costs can be as low as 15¢ per 1,000 std. cu. ft.

Fully automatic control is another feature cited by the Newark firm. Plant output increases or decreases automatically with demand, and product purity is constantly monitored.

Does West Coast carbon black plant portend tire-cord facilities, too?

With the opening of Continental Carbon Co.'s 50 million-lb./yr. carbon black plant in Bakersfield, Calif., another element is added to the West Coast tire-making complex. Only one part of an integrated tire-making operation is now missing: a tire-cord plant.

California, with its burgeoning population and car-conscious inhabitants (more cars per capita than any other state), has long been a favorite market for tire manufacturers. Over the years, a Western tire-making industry has been growing, initially fed by the replacement market, and now by sales to Western new-car assembly plants.

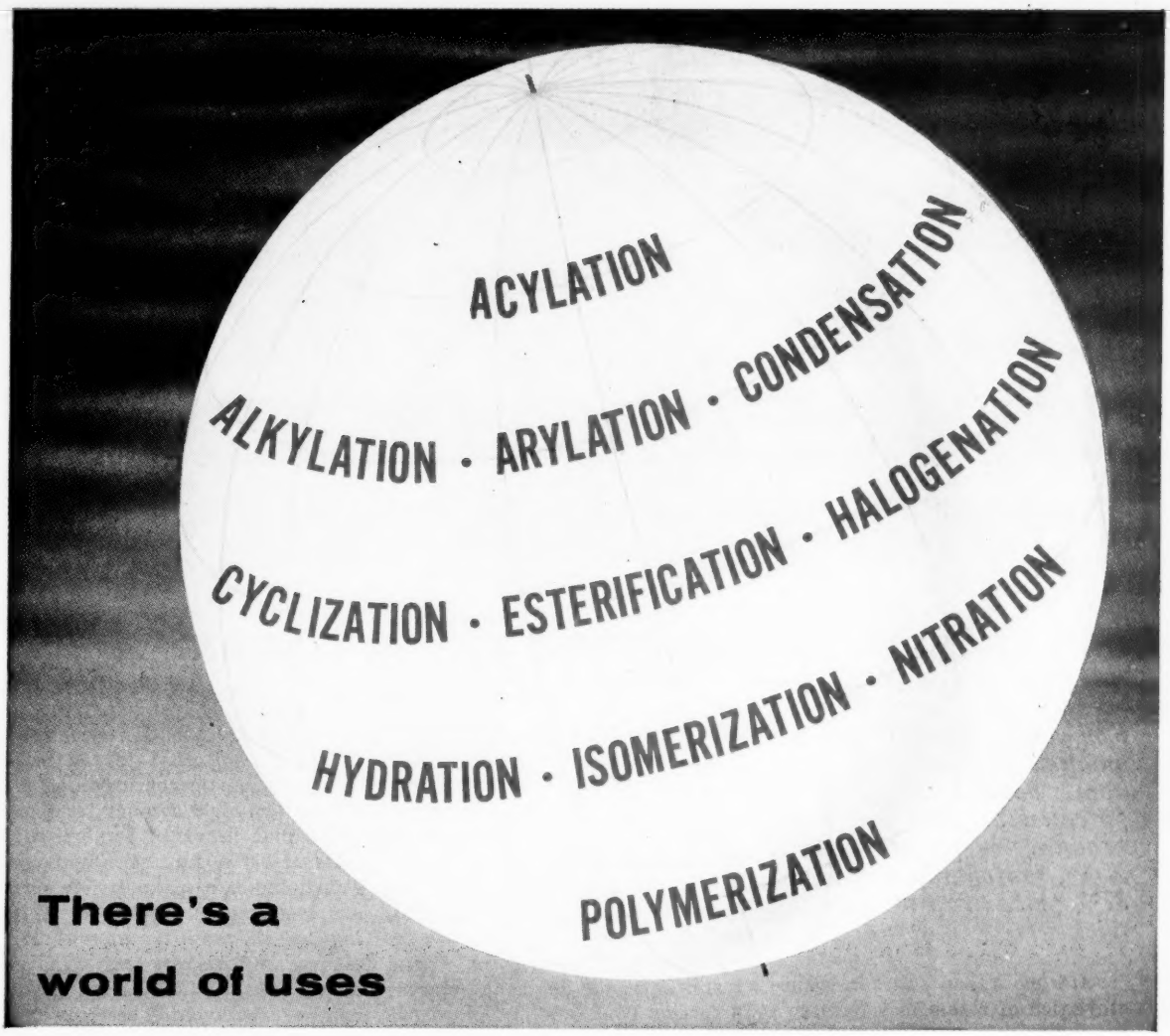
First came the tire makers and the synthetic rubber manufacturers; now, it's the carbon black producers, who plan to sell 95% of their total output to the rubber industry. In addition to the new Bakersfield plant, a 64-million-lb./yr. carbon black plant is to be built in Mojave, Calif., by United Carbon Co., Inc. Production is scheduled to start in late 1961 or early 1962.

More than one tire-cord manufacturer has ambitions to set up shop in California to serve the lucrative regional market. But it's the nylon-cord men who are really enthusiastic. Lured by the present 15-20 million-lb./yr. nylon tire-cord market in the West, they are banking on an upswing in the switch to nylon cord from rayon and their ability to build small nylon-6 tire-cord plants.

However, one logical contender, Allied Chemical Corp., has studied the situation carefully and decided against spending money on a Western tire-cord unit. Reason: Allied's management and its customers, the tire manufacturers, don't think the convenience of such a plant would justify the necessary expenditure. Instead, Allied would rather maintain Western warehouse facilities for tire cord shipped from the East.

Despite this decision by Allied, industry observers expect that rapidly growing tire sales will cause at least one nylon-cord unit to be located on the West Coast. They point out that with five tire makers already there (U. S. Rubber, Firestone Tire & Rubber, B. F. Goodrich, Goodyear Tire & Rubber, and Armstrong Rubber Co.), and others such as General Tire expected shortly, the technical-service advantages of a regional tire-cord plant will probably prompt at least one nylon producer to take the plunge in the not-too-distant future.

For More Industry & Economic News . . . p. 62



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Boron Trifluoride, Ether Complex, Tech	DA-34711
Boron Trifluoride, Monoethylamine Complex, Technical	DA-34661
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From 23¢/lb., acrylonitrile...

Has dropped to 14¢/lb. level.

At old price, consumers used 184 million lb./yr.

At new price, acrylonitrile may crack 500 million lb./yr. cotton treating market and...

Push capacity beyond 445 million lb./yr. level.

CAN CHEAPER ACRYLONITRILE CHARM COTTON?

For years, acrylonitrile has awaited a favorable economic balance to realize its potential as a rot-and heat-proofing agent for cotton. Now, the chemical's recent 37% price drop may do the trick.

After more than a decade, cyanoethylation of cotton may have gotten the push it needs toward commercialization, via acrylonitrile's recent dramatic price drop—from 23¢ to 14½¢/lb.

Simply, cyanoethylation anchors 3-5% nitrogen on the cellulose polymer: a caustic steep induces mild swelling of the fiber, catalyzes the reaction of acrylonitrile with it. Process yields a product that has improved dyeing properties and increased resistance to heat, rot and acids.

In answer to a *CE* query, C. H. Fisher, director of the Dept. of Agriculture's (USDA's) Southern Utilization Research & Development Div. at New Orleans, writes, "Our engineering and development laboratory estimates that lowering the price of acrylonitrile to 14½¢/lb. reduces the processing cost of cyanoethylating cotton approximately 20%, resulting in an estimated total cost of about 60¢/lb. of cyanoethylated cotton (CN cotton). This cost is about 3¢/lb. of CN cotton less than the cost based on acrylonitrile's old price. (These costs include cotton yarn at a price of 58½¢/lb. and are based on one pound of cotton yielding 1.16 lb. of CN cotton)."

▶ **Fantastic Possibilities** — For years, acrylonitrile manufacturers American Cyanamid and Monsanto —in cooperation with agencies such as the Institute of Textile Technology at Charlottesville, Va., and USDA's Southern Utilization Research & Development Div.—have worked at process improvement in laboratory and pilot plant. Keeping them at it, though the process has yet to catch on commercially, have been acrylonitrile's dazzling market prospects.

According to the National Cotton Council, a total of 294 million lb. of textiles was consumed in 1960 in markets where resistance to heat is important; 135 million lb. of this was cotton, but the rest—presumably served by more-expensive materials—represents fair game for CN cotton. A total of 2 billion lb. was consumed in markets where mildew resistance counts; 600 million was cotton.

For every 6 lb. of CN cotton produced, roughly 2 lb. of acrylonitrile is required. Pushed to the most wildly optimistic conclusion, then, the market could account for some 500 million lb./yr. of acrylonitrile.

Assuredly a fantastic figure, it would eliminate acrylonitrile's serious overcapacity problem by soaking up all capacity, present and planned. At the very least, it gives hope of a substantial market, if and when cyanoethylation becomes commercial.

▶ **Urgent Need** — Acrylonitrile makers certainly need such a hope. U. S. Tariff Commission statistics put production of acrylonitrile in 1960 at 229 million lb., with sales at 184 million. But total capacity will just about double that production figure when Du Pont—formerly one of the acrylonitrile market's biggest customers—doubles its still-new 50-million-lb./yr. capacity early next year.

▶ **Old Markets**—While many industry observers feel that the lower acrylonitrile price will have little effect on major existing markets in fiber, rubber and plastics (see table), V. Norman Luke of Shell Chemical Co., Ltd., expresses the opposite viewpoint. In a paper before the International Plastics Convention, held in London just prior to the acrylonitrile price

drop, Luke noted, "Total consumption of styrene-acrylonitrile copolymers today is probably less than 20,000 tons. But a lower price would probably have a fairly sharp effect on consumption.

"Expanding acrylonitrile consumption allied to the development of new manufacturing processes seems likely to make acrylonitrile cheaper. Both styrene monomer and butadiene are already cheap, so that price trends for both styrene acrylonitrile copolymers and acrylonitrile-butadiene-styrene (ABS) polymers are likely to be downward as consumption expands.

"Annual consumption of ABS polymers in the U. S. alone could reach 300 to 500 million lb. before 1970 and announced annual capacity for 1962 is already 125 million lb. Three companies are already in production in Europe and seem likely to be joined by several more."

▶**New Markets**—Hope for additional volume consumption of acrylonitrile is based on new markets. Cyanoethylation of paper and cellulose are possibilities that already have gone commercial.

Two years ago, General Electric commercialized a process for the cyanoethylation of kraft paper (U. S. patent 2,535,690) to use as insulation in transformers. The new paper, manufactured for GE by Hollingsworth & Vose, East Walpole, Mass., holds up for long periods under temperatures that would quickly degrade untreated kraft.

Last year, American Cyanamid introduced a new form of cyanoethylated cellulose, called Cyanocel, which can "hold" more electricity (higher dielectric constant) than other organic materials.

A sampling of promising possibilities uncovered at USDA's New Orleans laboratory:

• Acrylonitrile reacts with tung oil to yield products that can be used as plasticizers for polyvinyl chloride or acrylonitrile rubbers. Similar plasticizing oils could be made from esters of conjugated linoleic acid and acrylonitrile.

• It reacts with castor oil to yield interesting chemicals; some can be used as plasticizers and some as fungicidal or fungistatic agents.

• Graft polymers of cotton can be made with acrylonitrile by initiating the reaction with high-energy irradiation or suitable chemicals. The resulting modified cottons have much greater elongation, slightly improved resiliency.—FA

Acrylo capacity is about 50 % over. Needed: New markets

Producer	Capacity, Million Lb.
American Cyanamid	100
Du Pont	100*
Goodrich Chemical	35
Monsanto	100
Sohio	40
Union Carbide	70

*50 million under construction

End-Use,	%
Fibers	60
Rubber	15
Plastics	12
Misc.	13

Company Backs Own Resin With Plastic-Pipe Plant

It's official now. Du Pont is entering the piping business. Using its own Delrin acetal resin, the company will produce 5 million lb./yr. of plastic pipe by next summer upon completion of a $1.5-million plant in Tulsa, Okla. Du Pont's decision is based on three years of successful tests in the Southwest and other oil-producing regions.

Combining the strength and endurance of metals with the light weight and corrosion resistance of plastics, Delrin pipe can compete with metals on both a performance and cost basis.

Lengths of pipe are joined by a simple heat-fusion method that can be performed on the job in 25 seconds, and yields a leakproof joint stronger than the pipe itself. Three men, working together, can lay as much as 800 feet in one hour.

But the biggest selling point is the pipe's resistance to pressure surging, which is a problem in oilfield operation. As evidence, Du Pont has reported that Delrin's toughness, as measured by impact tests and fatigue endurance of 5,000 psi., is the highest for any known plastic—greater than PVC (polyvinyl chloride) ABS (acrylonitrile-butadiene-styrene), high-density polyethylene, or cellulose-acetate-butyrate pipe.

Since last year, more than 30 miles of Delrin pipe have been installed for crude-oil flow lines, as well as gathering, water-flood and salt-water-disposal lines.

Oil Refineries Complete Smog Reduction Program

Air over Los Angeles is significantly freer of carbon monoxide now that the five oil refineries in the area have completed their cooperative program of installing waste-heat boilers to oxidize the fumes and recover the heat.

Through their combined efforts, Richfield, Shell, Standard, Union and Texaco have reduced the amount of carbon monoxide discharging to the atmosphere by an estimated 1,582 tons per day. Still to be eliminated is another 9,050 tons per day emanating from motor vehicles, and 350 tons from isolated stationary sources.

Commenting on the refinery program early in August, Ernest E. Debs, Chairman of the Los Angeles County Board of Supervisors, noted that total cost of the program to the refineries was $8 million. However, Debs explained that fuel savings and reduced personnel requirements will enable the refineries to write off boiler costs in less than ten years.

SHIPPER REVEALS HOW METHANE TANKER PERFORMED

Awaiting approval to import methane into the United Kingdom, Conch International discloses some things learned during trial transatlantic shipments.

Just over the horizon are commercial tankers for transoceanic shipping of liquid methane, which boils at −258 F.

That's the word from Conch International Methane Ltd., the London-based subsidiary of Continental Oil Corp., the Royal Dutch Shell Group, and Union Stockyard and Transit Co. of Chicago. Terms have been "finalized" by Conch with the Gas Council of Great Britain and a group of undisclosed French concerns for the importation of Sahara Desert gas into the United Kingdom. Approval by the British government is pending.

▶ **The Methane Pioneer**—It's been almost two years since Conch's prototype vessel, the *Methane Pioneer*, proved by a series of transatlantic runs that the shipping of liquid methane was feasible (*Chem. Eng.*, Dec. 14, 1959, p. 165). Since then, much has been written on the Pioneer's design and construction (and, of course, on the significance of her runs); but little has been said of her operating conditions and actual performance, which until recently were held as proprietary information.

Along with its proposed plans for commercial operation, however, Conch has now released a paper titled "Technical Aspects in Commercial Transportation of Liquid Methane."* This not only describes the operating conditions of the Pioneer, but also lists a number of design suggestions for commercial liquid-phase carriers.

▶ **No Problems**—Almost none of the anticipated problems in the Pioneer's voyages ever arose, despite the unexpectedly severe weather encountered during the 13½-month test period (winds up to 60 knots, angles of roll up to 45°).

For example, difficulties predicted due to the venting of boil-off gas never developed. Average daily boil-off for the seven laden transatlantic trips from Lake Charles, La., to Canvey Island, near London, was less than 0.46% of the 2,000-ton tank capacity.

In order to test beam stresses, sloshing, structure temperatures, maintenance, etc., voyages were alternately made with full, partly filled, and empty cargo tanks. Minimum and maximum average daily boil-offs were 0.43% and 0.49%, while the equilibrium boil-off at a docked standstill was about 0.35% daily.

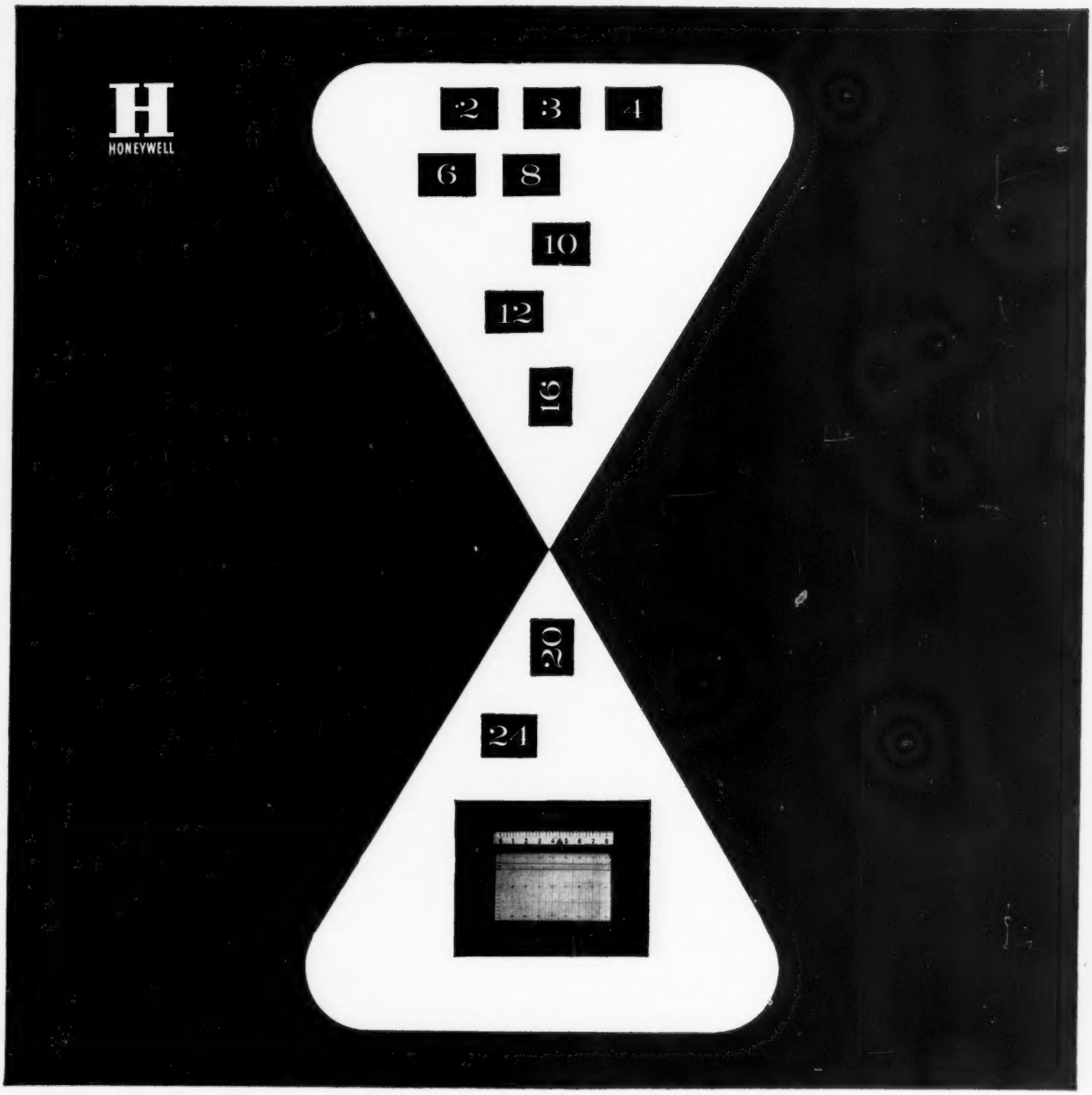
The nitrogen atmosphere enveloping the tanks was monitored continuously by an infrared analyzer for presence of methane leakage. There was no indication of methane in the holdspace.

Liquid cargo specific gravity was about 0.45; tank pressure, about 1 psig.; temperature, around −253 F. Examination of virtually all of the Pioneer's internal welds showed that the tank insulation proved effective in protecting the steel girders from embrittlement.

▶ **Commercial Recommendations**—But the performance of the test-sized Pioneer also pinpointed some design problems that Conch faces on its commercial-scale tankers. Touching on a few of the salient points:

Insulation—"The [cargo-hold] insulation," Conch stipulates, "should: (a) protect from the cold any sensitive part of the ship's structure, (b) retain its mechanical properties at low temperature, (c) adjust the rate of boil-off to the required value if the gas is used as

* Based on two staff articles of Conch Methane Services Ltd.: "Design and Transportation Aspects in the Handling of Liquid Methane," by E. M. Schlumberger and J. W. Hunt, and "Transportation and Storage of Liquid Methane," by C. L. Ritter and J. W. Hunt.



RECORD 2 TO 24 POINTS with ten-in-one "quick-change" instrument

With the new Universal Multipoint ElectroniK 15 Recorder on the job, you'll be able to change the number of recording points from 2 to 3, 4, 6, 8, 10, 12, 16, 20, or 24 in a matter of seconds. With this "quick-change" feature built into it, the new Universal can do the job of 10 recorders!

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If the monitoring jobs in your laboratory, industrial shop, or industrial process require frequent changes in the number of records required, you'll want to get the complete story on the new Universal Multipoint ElectroniK 15 Recorder.

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fuel, and (d) act as, or be a part of, the necessary secondary barrier."

How long this secondary barrier can contain the cargo is a matter of design. However, "it would seem reasonable to make efforts to obtain an efficient, long-lasting insulation unaffected by the cargo. This can be achieved . . . by an impervious plywood barrier backed by porous insulation such as balsa wood, in which a back-pressure could build up in case of liquid methane penetration."

Cargo Pumping—"A deepwell pump is . . . a natural choice, and this is what was employed on the *Methane Pioneer*, one in each of the five tanks. It is preferable not to have a sump in the tank floor. Since a boiling liquid is being handled, the pumps must therefore work at a very low Net Positive Suction Head (NPSH) when the liquid level is down."

Submerged Electrical Pumps—Alternatively to deepwell pumps, and at substantial cost savings, "there have recently become available some relatively high-speed, two-stage centrifugal pumps that can run at 3,500 rpm., but which have extremely low NPSH requirements. A prototype unit has been tested running for 700 hr. in liquid methane at −250 F. . . . No deterioration whatsoever [resulted]."

Boil-Off Disposal—"Now what is to be done with the boil-off? There again, it is a matter of economical choice between recondensing it or burning it as fuel. This will depend on the comparative cost of gas and bunker fuel, and on capital investment."

Despite the wealth of information contained in the paper, Conch has released few details on the proposed commercial vessels now awaiting government approval (*Chem. Eng.*, July 10, p. 55). Nor has indication been given on how long it might be before a liquid methane carrier is in operation in the Atlantic. However, it is known that the plan specifies the transport of 770,000 tons/yr. of liquefied methane (10-15% of U. K. fuel demand) from Arzew, near Oran in the Sahara Desert, to England by two British-built tankers.—EKS

NEW TANK CAR HAULS HYDROGEN FROM FLORIDA TO CALIFORNIA

Incorporating major advances in cryogenic engineering, this tankcar effectively blocks heat gain and product loss during transit.

Inside this jumbo tankcar, 28,300 gal. of liquid hydrogen (−423 F.) travels from West Palm Beach, Fla., to rocket development centers in California with only 0.3% evaporation loss per day, including loading and unloading operations. So efficient is the insulation responsible for this remarkable performance that only 1⅛ in. is used on the tank.

Perfection of this "Super Insulation" by the Tonawanda laboratories of the Linde Co., Div. of Union Carbide Corp., is credited with making possible the economical handling and transportation of cryogenic materials. Since first being announced in Sept. 1959, the material has been used on 10,000-15,000 cryogenic vessels.

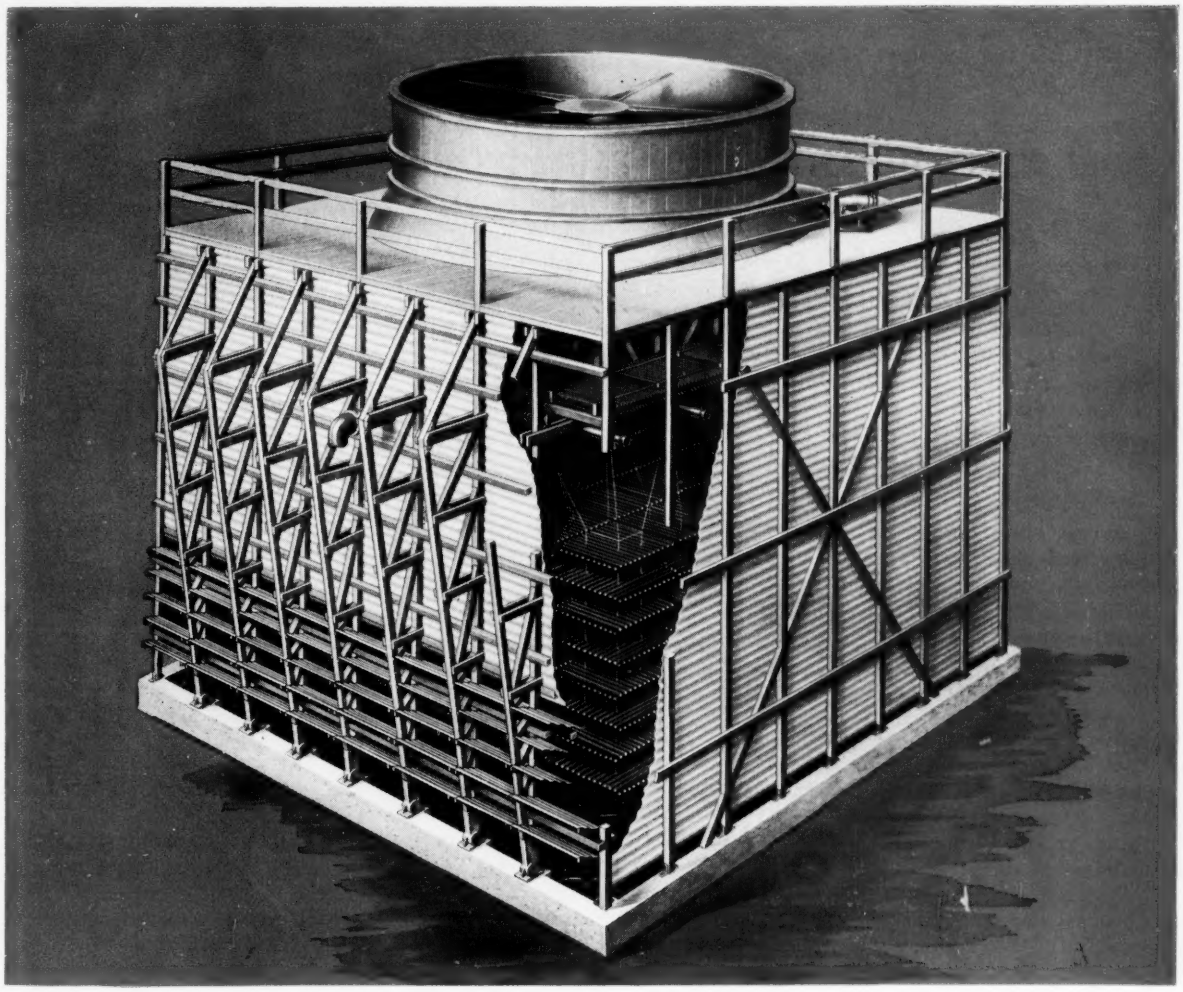
▶ **Supply Tie Line**—Between now and mid-1962, this insulation will enable Linde to transport 150,000 to 500,000 lb./month of hydrogen across the continent. These deliveries will provide an interim supply of liquid hydrogen under Linde's $31-million contract with the National Aeronautics and Space Administration (NASA) that includes building a new plant at Fontana, Calif., to supply 21 tons/day of liquid hydrogen by mid-1962.

Initial shipment of liquid hydrogen in the jumbo tankcar was completed in August. By the end of September, four of these units will be operating, with two more scheduled to follow at a later date. In addition, Linde will use 35 converted oxygen-nitrogen tankcars rated at 9,500-gal. capacity and 12 to 14 trailers of 7,800-gal. capacity.

▶ **Product of Pooled Talent**—To engineer a special tankcar that would meet its rigorous needs, Linde worked closely with General American Transportation Corp. (GATC). At Sharon, Pa., GATC built the carbon steel outer shell and special underframe components, including the soft-riding Hydra-Cushion.

Construction of the inner vessel and final assembly of the 77-ft., 8-in cars takes place at Linde's Tonawanda, N. Y., shop. During this operation, Linde installs the insulation. Consisting of alternate layers of glass fibers and aluminum foil under vacuum of minus 1 micron, the insulation has a heat transfer coefficient of 2×10^{-5} Btu. (hr.) (sq. ft.) (deg. F.).

Fully loaded with liquid hydrogen (0.58 lb./gal.), a 28,300-gal. jumbo tankcar will weigh 158,000 lb., well within the limit set by U. S. mainline railroads to avoid damage to wheels and tracks.



New idea...no structural internals

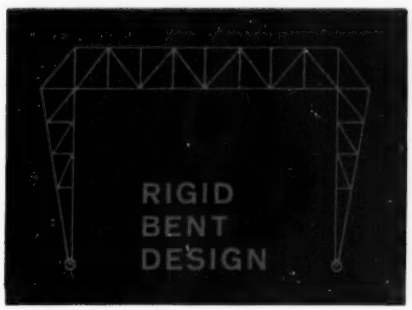
The *interior* of this new Foster Wheeler cooling tower is *completely free of structurals* below the roof trusses.

It is Foster Wheeler's new Rigid-Bent design featuring tapered built-up columns outside the tower sheathing, away from the moist, corrosive atmosphere within.

In every application, particularly where water chemistry and biological attack are serious problems, the FW Rigid-Bent design offers . . . isolation of vertical structurals from corrosion and biological attack . . . and uncommon ease of inspection, maintenance and replacement of all parts.

Space requirements and operational characteristics are the same as those attainable with older designs. Increased capacity by the addition of cells is no problem. Structurals are easily inspected and repaired during tower operation.

If you are currently considering an installation, let us provide you with further information. Write to Dept. CT, Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.



All tower internals are suspended from roof trusses. Cable-hung fill racks are quickly lowered to ground level for inspection and maintenance.

FOSTER WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

POLYSTYRENE SHAPES UP FOR WORLD MARKETS

Out of vistas clouded by overcapacity, plunging prices, and markets crowded with other polymers, Free World consumption promises to double or even triple during the '60s.

Almost every forecaster generally selects plastics as the group of materials most likely to justify glowing predictions of industrial growth during the 1960's. In the case of polystyrene, however, the glow will be generated mainly by the heat of competition.

And there is a danger that diminished profit margins may limit the resources available for research and development on which the future growth of the industry ultimately depends.

Thus, V. Norman Luke of Shell Chemical Co. Ltd. summarized his view of "Polystyrenes in the 1960's" at the recent International Plastics Convention in London.

▶ **Complications**—Rising overcapacity, falling prices, and predatory competitors are all contributing full measure to the aggravation.

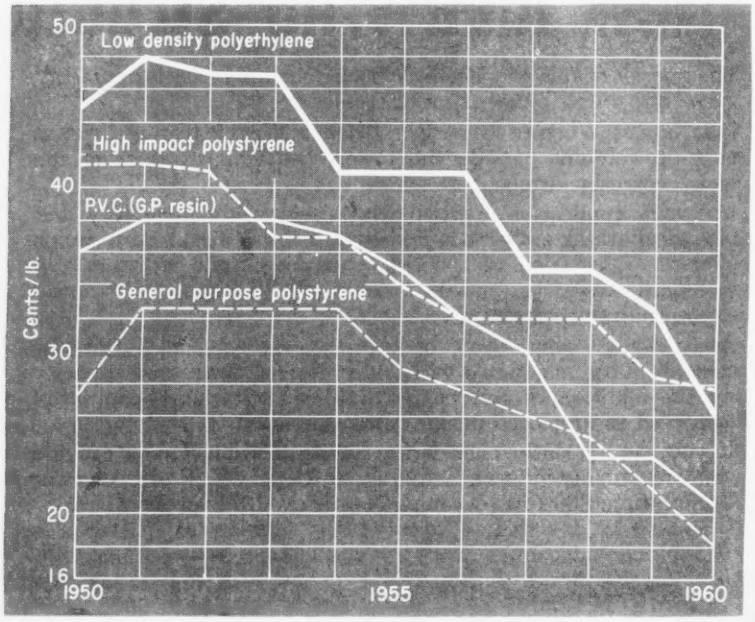
Two Much—There seems to be little prospect that existing capacity can be fully employed before 1963, yet new plants continue to be planned. Announced nominal capacities for the Free World already amount to about 850,000 tons/yr. for 1962, some 300,000 tons in excess of 1960 total consumption. Official plans of the U.S.S.R. and its European satellites call for 200,000 tons annual capacity by 1965.

Too Little—In January of this year, U. S. domestic prices dropped to new low levels and this trend has been followed worldwide. U. S. domestic prices do not, however, tell the whole story.

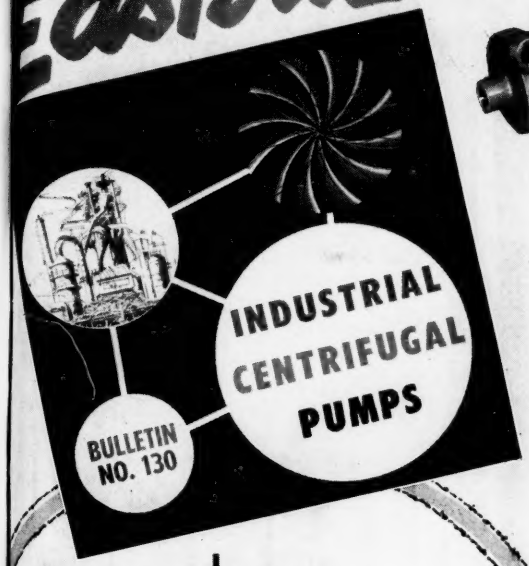
Competition in export markets is exceptionally fierce, with some manufacturers prepared to accept below 15¢/lb., fob., for crystal gen-

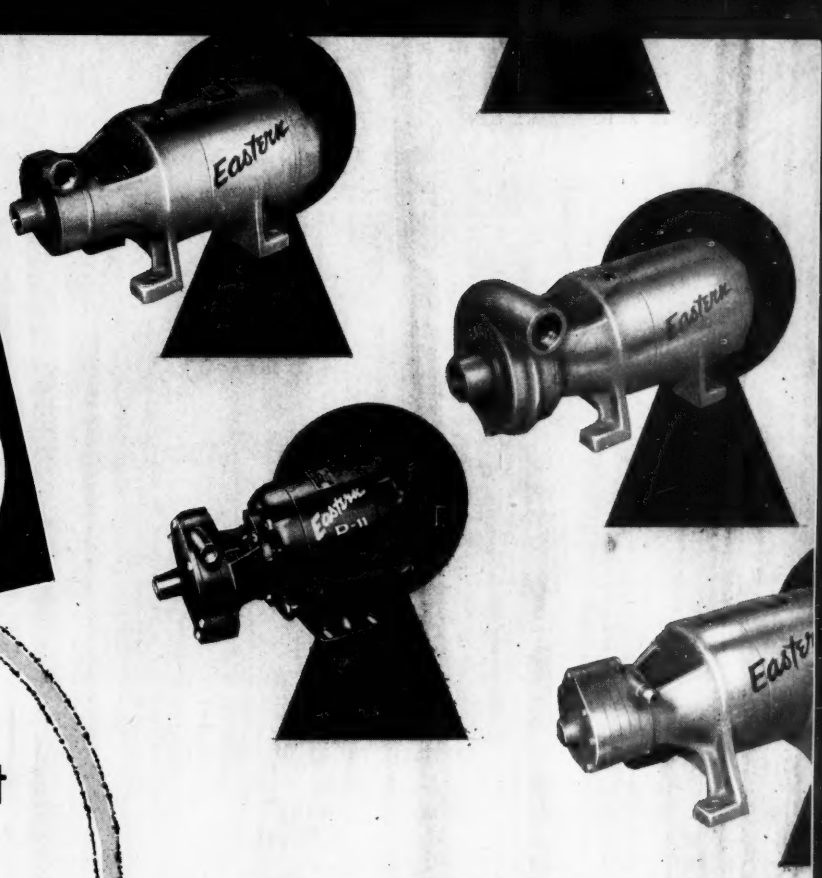
Most countries have been in production less than a decade

Low man on price scale: good for sales; bad for profits



Eastern





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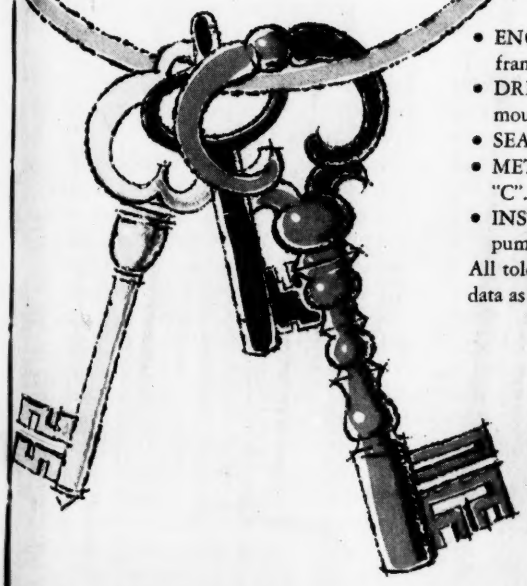

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If you need centrifugal pumps with these characteristics, this reference book is for you:

- PRESSURES: to 21 psi in single stage pumps; to 70 psi in multi-stage types.
- FLOWS: capacities to 70 gpm in single-stage pumps, to 10 gpm for multi-stage models.
- MOTORS: standard motors for 115/230 volts 60 cycles 1 phase (other electrical characteristics available). Power range from 1/8 to 1½ H.P.
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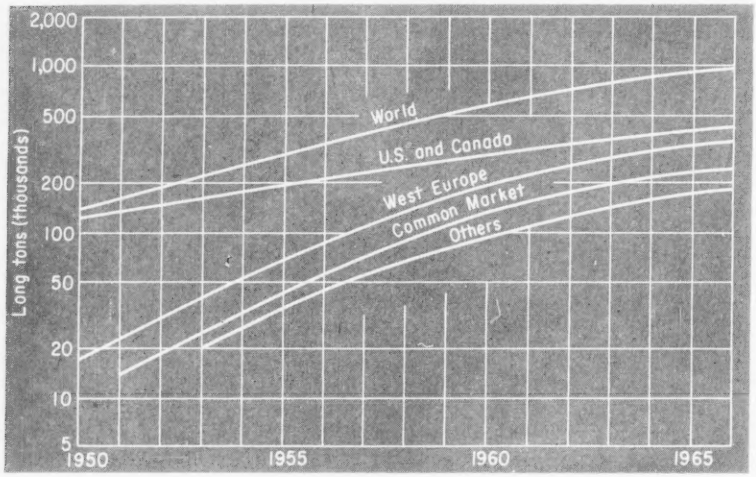
Polystyrene use looks for healthiest growth abroad



eral-purpose polystyrene. British home market prices fell sharply in August 1960 and again this April; some grades of toughened polystyrene are now selling below American domestic prices in a market only one-ninth as large. A parallel situation has existed in low-density polyethylene since November 1960.

Says Luke, "Current prices are considered unrewarding, particularly by manufacturers who've been accustomed to support the general development of the industry by intensive research, development and technical service programs."

Too Many—Competition between individual thermoplastics for the same application will become sharper in the next few years, and price margins between them may well narrow in consequence. The distress caused by overcapacity and low prices is not confined to polystyrene. Most plastics are similarly afflicted.

Even within the polystyrene family, there is in-fighting between new and old varieties. The new acrylonitrile - butadiene - styrene polymers—whose annual consumption, according to some commentators, could rise from a current 25,000 lb./yr. to 500 million lb. before 1970—will, Luke believes, achieve a considerable proportion of their growth at the expense of rubber-modified polystyrene.

► **Compensations** — Fortunately, there are several compensating factors mid all the strife.

Back in 1957, when total consumption of polyolefins passed that of polystyrene, some forecasters were convinced that the latter's growth would be halted by a flood of new competing materials. But it was the excellent 1959 consumption figures for the Free World—500,000 tons compared with about 350,000 in 1957—that have encouraged the many announcements of new polystyrene capacity.

Luke attributes polystyrene's continued expansion to: (1) falling prices and (2) the policies of continuous technical improvement and product diversification followed by major manufacturers.

► **Price Advantage** — Though prices of all major thermoplastics have dropped considerably over the past decade, general-purpose polystyrene has retained its position as the lowest-priced thermoplastic. Low-density polyethylene went from 45¢/lb. to 36¢ between 1950 and 1960; general-purpose polyvinyl chloride resin went from 36¢ to 20¢; general-purpose polystyrene, 27¢ to 18¢. During this period, impact polystyrene remained competitive with conventional polyethylene.

► **Product Development** — Manufacturers have demonstrated their ability to make continued improvements in homopolymer and rubber-modified grades, providing greater ease of molding, increased strength, stability and heat resistance, and color possibilities unsurpassed by other plastics. Now some are pressing on with the development of copolymer and expandable grades.

The rubber-modified materials have played an important part in the growth of polystyrene's consumption in the past decade. In the more sophisticated markets, they probably account for about 35 to 40% of usage, compared with 45 to 50% for homopolymers, the balance being copolymers and expandable materials.

The available statistical data do not permit an analysis of grade usage or growth in various applications. But it is generally accepted that rubber-modified materials have been growing relatively faster than homopolymers.

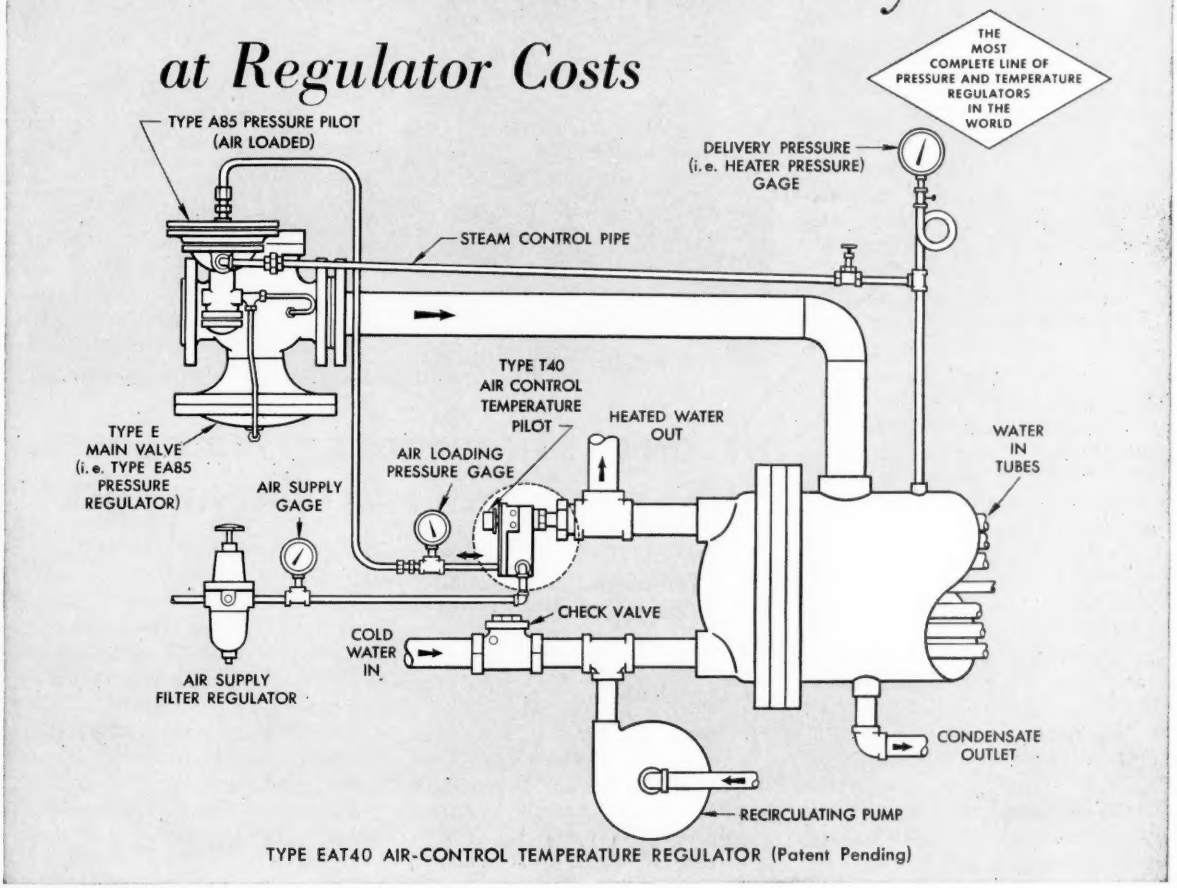
By 1970, homopolymers are expected to account for only 25% of resin usage, rubber-modified grades for 33%. The balance left for copolymers and expandable materials will, by that time, reach almost half of total consumption.

The introduction of complex homopolymer and copolymer-grade patterns can reduce effective production substantially, thus reducing the awesome overcapacity expected a few years hence. The 850,000 tons expected in 1962, for example, represents capacity in terms of straightforward general-purpose crystal production.

► **Integrate to Win**—Established manufacturers of polystyrene resin seem certain to continue expanding the range of their activities. Luke foresees much more vertical integration into conversion operations.

Developments in machinery as well as materials are likely to play an important part in building up markets. Great hopes are pinned on techniques such as in-line vacuum forming of disposable containers, and biaxial orientation to produce strong, clear films capable of being cold-formed to produce trays for foodstuff packaging. Also, close cooperation growing between polymer maker, machine maker and

New Spence Temperature Control System with Cascade Control Accuracy at Regulator Costs



TYPE EAT40 AIR-CONTROL TEMPERATURE REGULATOR (Patent Pending)

In a recent installation the new Spence air-control temperature regulating system provided:

- ±5°F control accuracy under wide and instantaneous load swings of 210 to 80 gallons per minute.
- Up to 50% reduction in cost as compared to instrument systems of similar accuracy.

This unique cascade-type control with throttling range adjustment independent of maximum heater pressure was developed to meet today's demand for greater control accuracy.

Additional features of the new Spence Temperature Control System include:

- 200°F wide adjustable temperature range
- Adjustable speed of steam pressure change
- Over and under temperature protection
- Pressure limit control
- Fast response
- Very low air consumption
- Field reversible for heating or cooling

The Spence Type EAT Air Control Temperature System, when properly installed, will tame wide ranging, fast changing loads of instantaneous heaters and modern heat exchangers. The cascade principle plus the use of an extremely fast responding bi-metal temperature sensing element reduce time lags and provide control stability.

Here's how the new Spence system operates:

Quick response is based on a bi-metal temperature sensing element. Temperature pilot continuously regulates a loading air pressure.

This loading signal, when applied to a pressure regulator to reflect heater temperatures, causes it to adjust the main valve as changes in load require.

Spence has also developed a new pressure control system based on this same cascade principle. This system has a control accuracy of ½ psi or better from positive pressures through the vacuum range to 30" Hg.

For complete information on these new air controlled temperature and pressure control systems, write for your copy of Bulletin 9.

SPENCE ENGINEERING COMPANY, INC.
Walden 1, New York SE-148A

product designer will maximize economy of production.

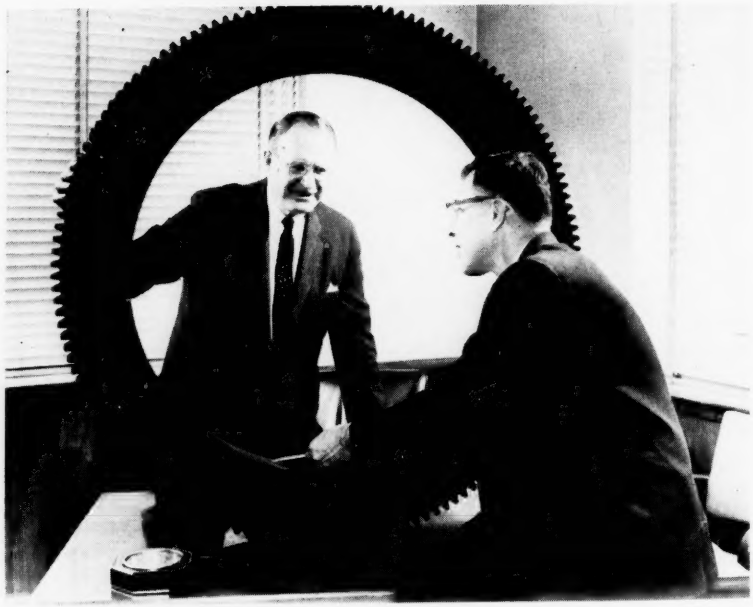
Crystal general-purpose polystyrenes are now virtually commodities due to the ready availability of styrene monomer and the wide dissemination of manufacturing know-how. It seems likely that major manufacturers will concentrate their research, development and technical service resources on the newer and potentially more profitable polystyrenes such as foams and copolymers. They'll continue to cater to the expanding markets for the simpler materials by means of large volume, integrated monomer and polymer operations.

There seems to be no shortage of risk capital for relatively small-volume operations that are founded on purchased styrene monomer and that manufacture only the simpler variants of polystyrene. But for large-volume operations producing a full range of homopolymers and copolymers, only established enterprises show much promise.

The returns available may well deter all but the most determined new entrants, except in countries, such as the U. S. and Italy, whose industries are protected by high tariff barriers or by import restrictions and tariff barriers combined, as in India.

▶ **Future Use**—A conservative extrapolation of past consumption trends suggests that total Free World usage should reach the million-ton mark in 1966 or 1967, with the U. S. and Canada accounting for some 400,000 tons of the total. Continuation of the trend suggests a total of over 1.25 million tons by 1970. More optimistic, Luke sees a 1.4-million-ton figure for 1970.

The growth rate of total consumption in the past decade has been appreciably above that in the U. S. and Canada, reflecting the later but more-rapid establishment of polystyrene in Europe, in particular. Japan is now starting to make a significant contribution to consumption, and figures recently published show a remarkable increase in production, from under 14,000 tons in 1959 to almost 22,000 tons in 1960.—FA



NYLON CASTING PROCESS CUTS COSTS, MAKES LARGER PARTS AVAILABLE

New technique for creating large, complex nylon parts directly from monomer is expected to help sell nylon as substitute for metals.

Polymer Corp.'s disclosure of the details of its patented technique for low-pressure casting of large, complex nylon parts has drawn favorable comment from industry (*Chem. Eng.* Aug. 7, p. 55). In the opinion of most, it's an important boost for the nylon industry's campaign to sell nylon as a metal substitute, especially in gears, bushings and other cast-metal parts. But, these same people hasten to add that they have known about Polymer's process for some time and that there are other ones claiming similar results.

Until recently, nylon parts were made by first polymerizing nylon monomer, then molding the hardened polymer under high pressure and temperature. Large nylon shapes (over 3-in. thick) were almost impossible to mold directly, and had to be machined from bar or rod stock. Now, Polymer engineers can create a variety of large, complicated shapes from nylon 6 monomer by in-the-mold polymerization at low temperature (150 F.) and atmospheric pressure.

Called monomer casting, the process is based on discoveries in nylon polymerization chemistry patented by Monsanto Chemical Co. Polymer Corp., exclusive licensee of the patents, has been cooperating with Monsanto to develop casting tehniques.

Company engineers haven't revealed how they polymerize nylon at low temperatures, but early Monsanto patents indicate the use of both an alkali-metal catalyst and a nitrogen compound.

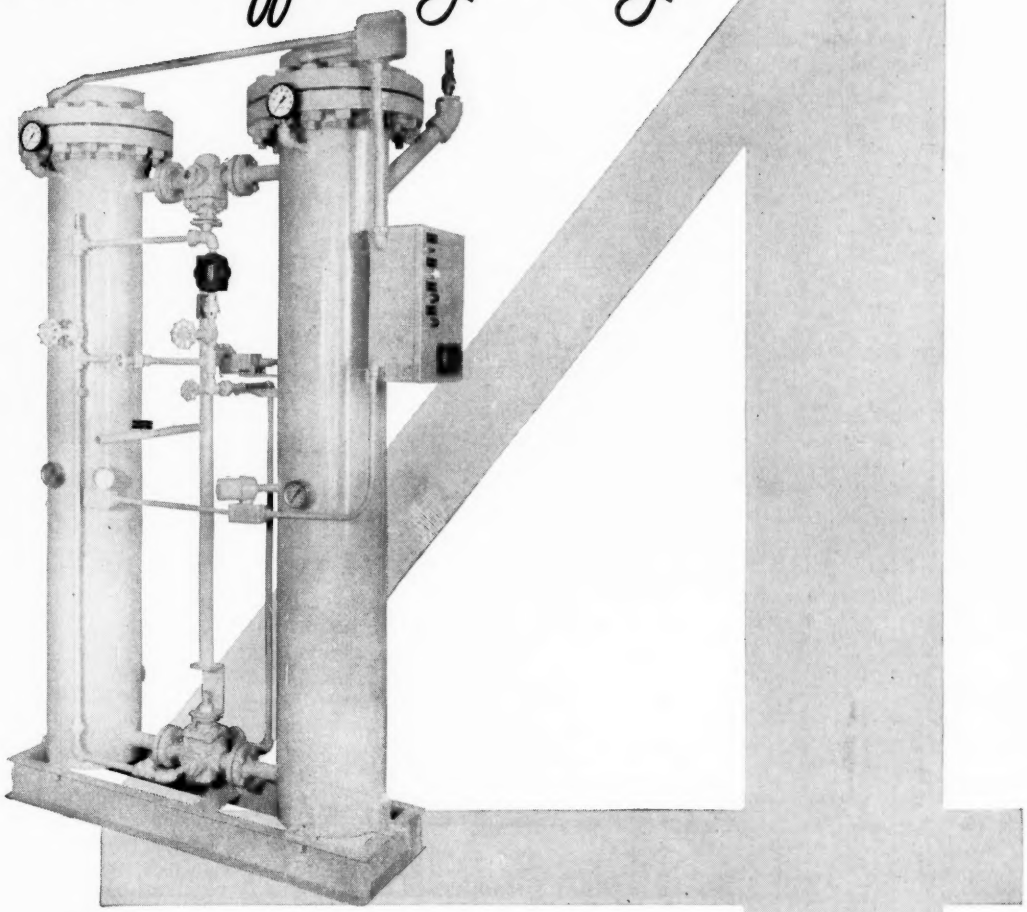
According to information released early last month, the advantages of the plastic, tradenamed MC nylon, are fourfold:

▶ **Lower Costs**—Monomer casting eliminates the use of pelletized polymer, uses raw monomer directly. Estimated raw material costs: $0.46/lb. for the monomer, $0.98-$1.03 for the polymer. Fin-

cont'd on page 74

KEMP ORIAD DESICCANT DRYERS

cut costs, add efficiency 4 ways!



1 Complete reactivation

An exclusive 3-zone embedded heater design gives every Kemp Oriad Desiccant Dryer extra drying power *economically* (effective distribution of heating elements assures high heat transfer efficiency). The most complete reactivation results... providing maximum desiccant capacity, minimum dewpoint performance.

2 Full automatic operation

Set the program timer and everything is regulated automatically. Gases are dried with the least pressure loss, lowest maintenance and operating costs. Your choice of manual or semi-automatic systems, too.

3 Accurate temperature control

Thermostatic control conserves heat input... maintains ideal temperatures for highest operating efficiency in drying instrument air, process air and gases to the lowest dew point, eliminating condensation or freeze-up, and other applications.

4 No moving parts

There are no blowers, fans or motors to create maintenance problems, rising operating costs. Unit comes fully assembled, ready to go. Liquid dryers also available. Write today for Bulletin D-103, or contact your Kemp man, listed in the Chemical Engineering Catalog.

It always pays to come to

KEMP OF BALTIMORE

THE C. M. KEMP MANUFACTURING COMPANY
405 E. Oliver St., Baltimore 2, Md.

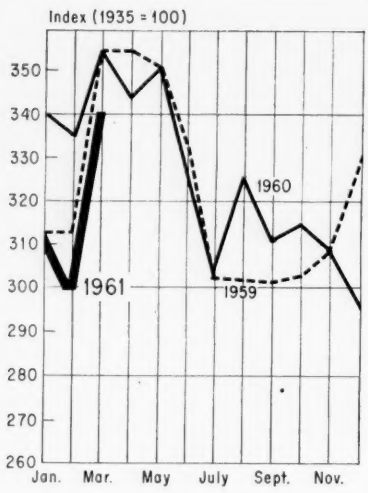
ished-part costs should drop from the present $3-5/lb. to $1.25/lb.

▶ **Unlimited Part Size**—"Theoretically, there is no technical limitation to the size part that can be made," says one company official, though he adds that "markets must be developed for these newly available large sections."

▶ **Improved Physical Properties**—Researchers find that certain MC 901 nylon properties are better than those of most nylon 6 formulations. For example, its heat-distortion temperature (at 66 psi.) is 425 F., 70 deg. higher than that of nylon 6.

▶ **Economical Fabrication**—Monomer casting is said to eliminate much of conventional tooling costs and process limitations. If so, costs of custom-tailored nylon parts and extra-large shapes could be sharply reduced.

Louis Stott, Polymer Corp. president, declined to predict MC nylon sales figures. He did, however, emphasize that MC nylon would not compete with injection-molded nylons but would strive to open new markets for large nylon parts.



Chemical Consumption Index

	Feb. (Final)	Mar. (Est.)
Coal products	6.1	6.9
Explosives	9.6	10.5
Fertilizers	80.1	88.8
Glass	27.4	32.6
Iron & steel	11.4	13.0
Leather	4.1	4.1
Paint & varnish	27.9	35.3
Petroleum refining	30.6	32.4
Plastics	27.6	32.1
Pulp & paper	39.2	44.3
Rayon	20.9	24.5
Rubber	6.0	6.6
Textiles	8.5	9.7
Total	299.4	340.8

Paper Mill Hopes to Get Nuclear Steam Supply

Fitchburg Paper Co., Fitchburg, Mass., has applied to the AEC for a participating role in the demonstration project for generating low-temperature process steam from nuclear reactor heat. If selected, Fitchburg will put its existing oil-fueled power plant on standby, relying on nuclear heat to supply the large amounts of steam for power generation and drying at its paper mill. Output capacity will be 30,000 to 40,000 kw. (thermal) at 15-200 psi. steam pressure.

New Pipelines Link Delaware Valley Plants

Some of the pipelining philosophy that led to Houston's "spaghetti bowl" pipeline system seems to be taking root in the East. Now shaping up is a chemical pipeline system that will link plants located in Pennsylvania, Delaware and New Jersey.

Starting at Marcus Hook, Pa., a pipeline will carry refinery gases to the Sun-Olin Chemical Co. plant at Claymont, Del. In turn, Sun-Olin will deliver ethylene, hydrogen and carbon monoxide into three separate pipelines that run under the Delaware River to a point near Bridgeport, N. J., then down to Du Pont's Chambers Works at Deepwater, N. J. A fourth pipeline will carry nitrogen to the Chambers Works from a new Air Reduction Sales Co. plant at Claymont.

The trans-Delaware pipeline will also supply the new Monsanto plant being constructed at Bridgeport, as well as other future plants.

Toy Gives Peek Preview Of Robot Painter on Wall

Climbing like a fly on a wall, this toy tractor demonstrates the maneuverability of a new robot tank painter designed by Esso Research and Engineering Co., affiliate of Humble Oil & Refining Co.

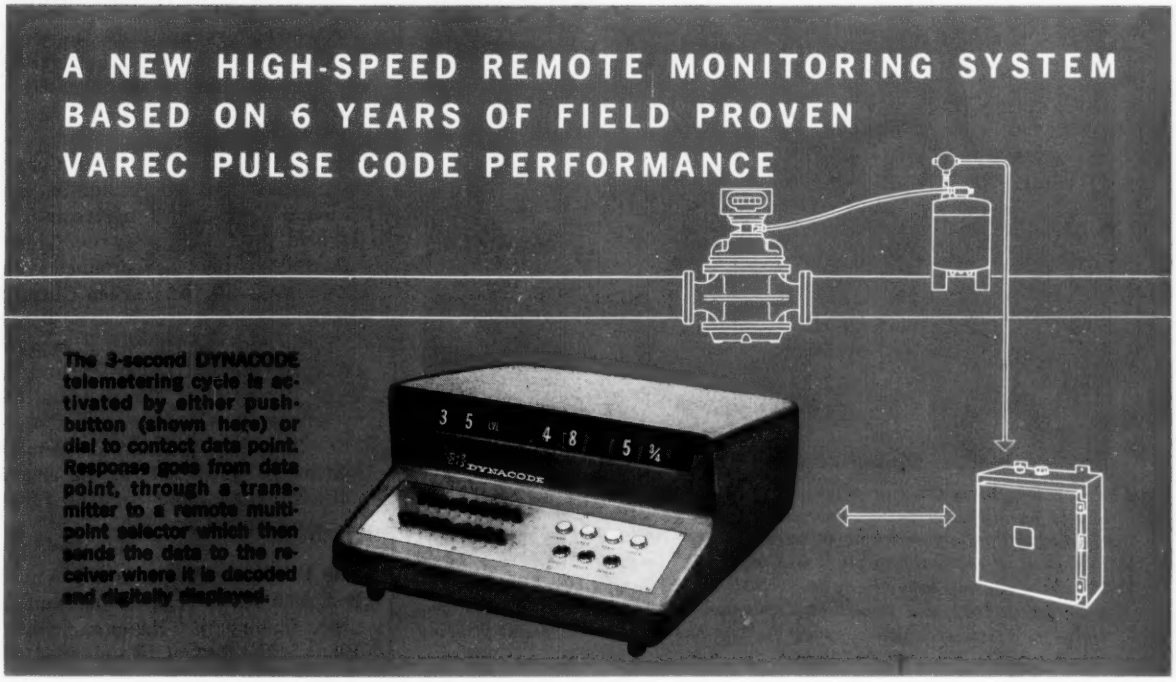
According to Esso, a preliminary model of the device has demonstrated the feasibility of using such a robot. Moving on continuous rubber treads that contain magnets, the robot could prepare and paint relatively smooth metal surfaces both vertically and horizontally, at 0.5 ft./sec. Chief potential applications appear to be large metal storage tanks and possibly ship hulls and decks.

Device will be driven by an air turbine and guided by an operator through pneumatic controls. After a mechanical chipper on the front of the robot prepares the surface, a pressurized roller on back applies paint supplied through a hose.

Esso has estimated that four of these "painters," about 3 ft. long and 1.5 ft. wide, could paint a medium-sized tanker in 16 man-days, compared with 200 man-days by conventional methods. Cost would range between 40 and 70% of present level.

DYNEL DYNACODE TELEMETERING SYSTEM

A NEW HIGH-SPEED REMOTE MONITORING SYSTEM BASED ON 6 YEARS OF FIELD PROVEN VAREC PULSE CODE PERFORMANCE



The 3-second DYNACODE telemetering cycle is activated by either push-button (shown here) or dial to contact data point. Response goes from data point, through a transmitter to a remote multi-point selector which then sends the data to the receiver where it is decoded and digitally displayed.

Dynel engineers—utilizing the performance proved concepts of Varec's famous Pulse Code system—have developed the significantly advanced DYNACODE telemetering system for remote readings of liquid level, temperature and P.D.M.

This single-channel, "error-proof" system combines the proven reliability of the basic Varec system with a digital readout time of 3 seconds per point... readout accuracy of 1/16 inch... readout capacity of an unlimited number of points... and readout versatility that permits the system to be tied into a general purpose computer for inventory, billing, and similar functions.

Solid state components are used at key points in the receiver design for longer, maintenance-free life. And DYNACODE, like Varec's Pulse Code, has an instantaneous alarm system without scanning delays.

The high-speed DYNACODE System offers these advantages:

Reliability: Design based on 6 years of performance in scores of pipeline and refinery applications.

Data Display: Illuminated, in-line digital display includes point and function identification, digital data to 6 significant figures and liquid level to 1/16" increments.

Fast Response: data from any given point is gathered and digitally displayed in just 3 seconds.

Flexibility: Designed on building block principle that permits a great variety of system arrangements... DYNACODE is compatible with all standard systems of measurement.

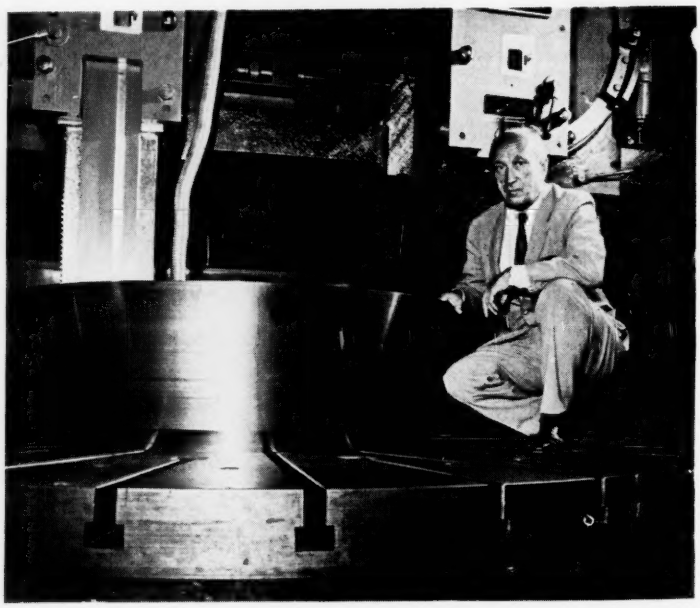
Readout Variety: digital output provides a variety of readouts, including visual display, paper tape, typewriter, etc. Output is compatible for use with general purpose computers.

For complete information, see DYNACODE at the ISA Show, Los Angeles Sports Arena – Booth #170. Or write for Bulletin 301, Dept. CHE-1600-2

DYNEL, Inc., *a subsidiary of Varec, Inc.*

12923 S. Spring Street, Los Angeles 61, California • Branches and Representatives in Principal Cities

Bustling business in beryllium



Brush Beryllium Co.'s president, George S. Mikhalapov, displays a thin-walled beryllium structure fabricated by the firm's new 120-in. vertical boring mill. Giant machine is part of the hardware just brought into operation at a $3-million plant in Cleveland, boosting Brush Beryllium's metal fabricating capacity by 50%. Still under construction (Chem. Eng., *June 12, p. 106) is a $6-million expansion of the firm's nearby Elmore, Ohio, facilities, at which capacity for the basic beryllium metal is being hiked from 18,000 to 30,000 lb./mo.*

Plants

National Starch and Chemical Corp. plans a $4-million vinyl acetate monomer facility in Texas. Merits of two Gulf Coast sites are being weighed. Construction by Brown and Root, Inc., on the 45-million-lb./yr. unit is scheduled to begin late this year, with completion slated for the fall of 1962. National Starch already makes 36 vinyl acetate polymers and copolymers at Plainfield, N. J., and Meredosia, Ill.

Kerr-McGee Oil Industries, Inc., has awarded the construction contract for its helium extraction unit at Navajo, Ariz., to Service Engineering Co. (Navajo is in the Pinta Dome natural gas field, whose 8% helium reserves have been estimated to contain 7.5 billion cu. ft. of recoverable gases.) Kerr-McGee's unit will be the only privately owned helium plant in the U. S. when it comes on stream November 1, turning out 200,000 std. cu. ft./day of 99.995% helium. The firm owns 90% interest in 12,409 gross acres, roughly 95% of the Pinta Dome structure.

Ethyl Corp. has placed its methyl chloride plant on stream at Baton Rouge. Rated capacity is 25 million lb./yr., but can readily be doubled. Part of the methyl output will be used captively, as an intermediate for TML and other alkyl-lead gasoline additives. Ethyl Corp.'s own construction crews erected the $500,000 installation.

United Engineering Trustees, Inc., a corporate entity founded by five engineering societies (AIChE, ASCE, AIMMPE, ASME and AIEE), has announced that former President Herbert Hoover will dedicate the $12-million United Engineering Center at New York's United Nations Plaza late in October. The 20-story building will house the offices of 19 professional engineering organizations, as well as what is believed to be the largest engineering library in the free world.

Heyden Newport Chemical Corp. has brought its 8-million-lb./yr. fumaric acid plant on stream at Garfield, N. J. Unit uses the Scientific Design process; product will be marketed by the Heyden Chemical Div.

Shell Chemical Co. has expanded styrene capacity at Torrance, Calif., by almost 70%. New capacity is 210 million lb./yr., up from 125 million lb./yr. Shell bought the original synthetic-rubber complex from the government in 1955.

The Flintkote Co. plans a $10-million, 46,000-ton/yr. asbestos-cement pipe factory in Ravenna, Ohio. Plant is the first of two planned by the firm as a result of a licensing agreement between it and Johns-Manville Corp. The latter will market Flintkote's product as "Transite."

In a separate development, **Jefferson Lake Asbestos Corp.,** a 77%-owned subsidiary of Jefferson Lake Sulphur Co., has begun constructing a 2,500-ton/day asbestos mill in Calaveras County, Calif. Facility will cost $5 million, come on stream by next March. Asbestos ore will be mined by Wells Cargo, Inc., under contract to Jefferson Lake Asbestos.

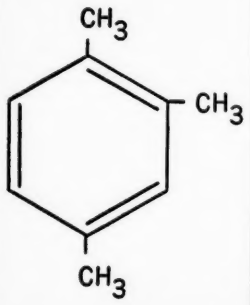
Pittsburgh Plate Glass Co. has begun constructing a 15,000-ton/yr. sodium chlorate plant at Lake Charles, La. Scheduled for production by September 1962, the multi-million-dollar unit will use an electrolytic cell developed by PPG for a Canadian subsidiary, Standard

Turn to p. 166 for more CPI News Briefs

What's News in Enjay Chemicals...

PSEUDOCUMENE

TYPICAL INSPECTIONS



Pseudocumene (wt per cent)	95.0
Distillation °F	
Initial	335
50 per cent	337
Dry Point	340
Color	Water White
Doctor Test	Pass
Flash (Tag Closed Cup) °F	119
Specific Gravity (60/60°F)	0.878

FIRST from Enjay in commercial quantities ... pseudocumene (1,2,4, trimethylbenzene) is now available for immediate delivery. Enjay pseudocumene is a low-cost, highly reactive, aromatic hydrocarbon which can be readily converted to intermediates for production of surface coatings, plasticizers, drugs, dyes and many other products.

Pseudocumene will be used commercially in large quantities to produce trimellitic anhydride for use in the manufacture of surface coatings and plasticizers. A blend of pseudocumene and bromobenzene has been found to possess a very high viscosity index, making it a possible useful hydraulic medium in control apparatus designed to operate over wide temperature ranges.

COMPLETE INFORMATION – For a new Pseudocumene Brochure #D-16, write to Enjay, Room 1131, 15 West 51st Street, New York 19, New York.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY

Protective coatings

Floor maintenance problems can be solved by urethane finishes and acrylic emulsions.

Today, there are two new compounds that seem to do a more satisfactory job in floor maintenance than alkyd or phenolic floor finishes. Here are some details:

▶ **Dries in Humid Air** — Applied with a roller or brush—without prior thinning — Du Pont's floor finish Imron will become tack-free in about one hour, if the relative humidity is over 50%. (Moisture in the air acts as catalyst.) Floors can then be buffed and recoated in three or four hours.

Usually, the higher the humidity and ambient temperature, the faster the dry. Sultry summer days would be ideal. When the humidity is below 50%, Imron finishes on cement or wooden floors would take about three hours to become tack-free.

This product is described as an oil-free, one-component system containing a urethane polymer terminated by an isocyanate group. It will dry to a tough, elastic, clear coating on interior wood or concrete floors subjected to the heavy traffic of textile or paper mills, industrial plants, food processing plants and the like.

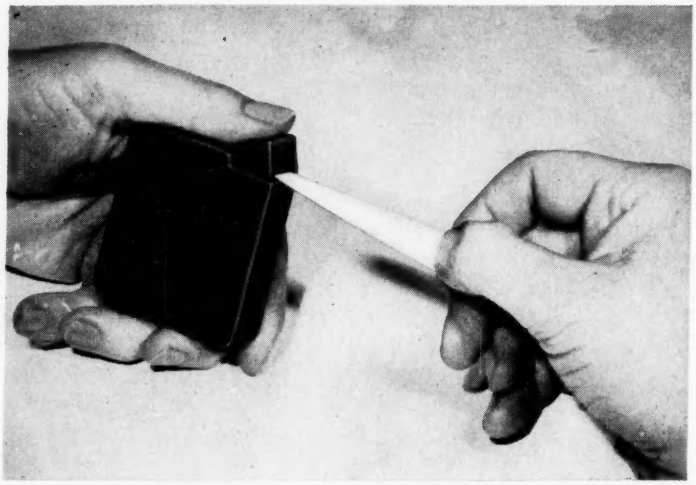
These coatings are easy to clean and are reported as exceptional in their resistance to the discoloration and softening action of lubricating oils, greases and machine-tool cutting oils.

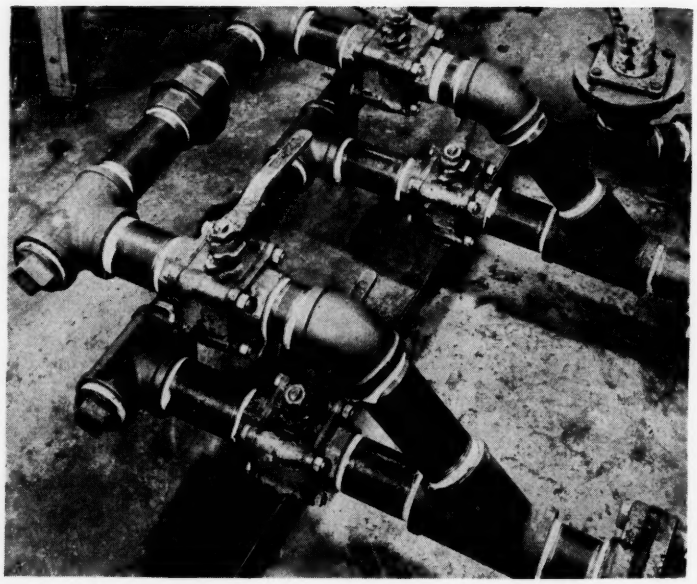
Sold in 5-gal. cans at $6/lb., Imron is said to last two to three times longer than high-quality varnishes.—**E. I. du Pont de Nemours & Co., Wilmington, Del. 78A**

▶ **Versatile Emulsions** — NeoCryl A-400 and NeoCryl A-410 are two light, translucent fluids made from an unidentified acrylic copolymer. In the emulsified state, they contain about 40% solids of 0.02-0.04 micron particles, can be formulated into several floor polishes that resist water, soaps and alkaline detergents.

The unusual feature of NeoCryl compounds is that they are both acid dispersible and acid soluble; polishes formulated by blending

Teflon tape quickens piping assembly





Flanged piping, with its expensive valves and fittings, can now be replaced by screwed piping, thanks to a patented Teflon tape called Ribbon Dope Thread Sealant.

Combining the well-known advantages of Teflon (i.e., chemical inertness to corrosive media, thermal stability from −450 F. to 500 F.), this tape molds itself to any threaded part and eliminates leakage even at pressures of over 10,000 psi. Pipe assembling and dismantling time can be drastically reduced because the tape has a friction coefficient of 0.04, which is below that of graphite and molybdenum disulphide lubricants. It can also be used to prevent electrolytic corrosion when joining threaded fittings of dissimilar metals.

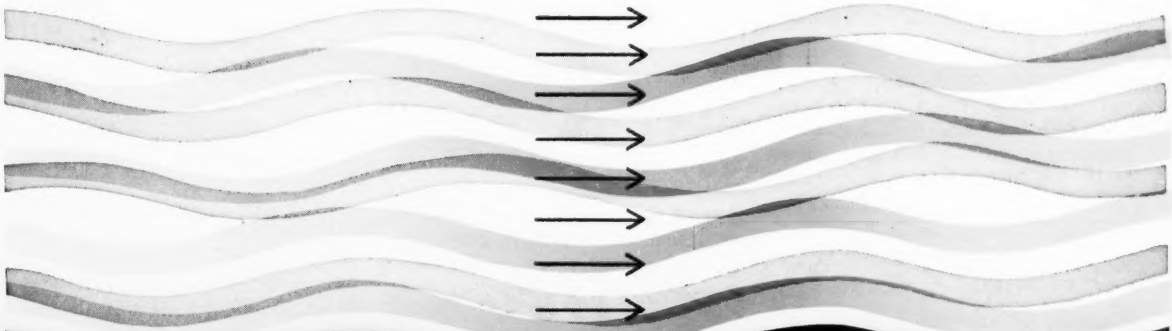
Ribbon dope has a thickness of 3-3.5 mils and an average elongation of 90%; it is available in roll form in 260 and 520-in. lengths.—**Permacel, New Brunswick, N. J. 78C**

Honeywell announces the NEW series 1400 low flow control valve

The addition of the new Series 1400 valve body to the Honeywell line of control valves now gives you a choice of actuator-body combinations to match your applications. Now you can choose the exact type and degree of control you need, without pushing a valve beyond its design limits . . . or without paying for more performance than you need.

The compact Series 1400 valve body is available in a full range of materials, ratings and sizes, with screwed or flanged ends. It can be used to regulate small flows in process, pilot plant, research and commercial control systems. Each body size (½", ¾" and 1") has a wide range of reduced ports with Cv's from .025 to 11.0. Two bonnet constructions facilitate mounting of five types of actuators —three pneumatic and two electric.

Each actuator-body combination fits a different range of operating conditions and performance characteristics, but with sufficient overlapping of these ranges to give you a wider selection on the basis of cost. For complete details, write for Bulletin B803-1. MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.



Model 1401 Low Flow Valve with heavy-duty pneumatic actuator for systems requiring high shut-off ratings and accurate valve positioning.

Model 1403 Low Flow Valve with compact, light weight pneumatic actuator for average industrial and commercial control systems.

Model 1404 Low Flow Valve with reduced port Cv's to .025 and top-mounted positioner integral with pneumatic actuator.

Model 1406 Low Flow Valve with *Modutrol* capacitor-type, electric motor actuator for two-position, floating or proportional control.

Model 1407 Low Flow Valve with heavy-duty *Actionator* electric motor actuator provides more power for higher valve shutoff ratings.

Honeywell

H First in Control

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

with wax emulsions and alkali-soluble resins will coat floors with a tough film that withstands traffic, mopping or scrubbing. Yet, when desired, these films can be easily stripped with mild acids.

Tributyl citrate, tributoxyethyl phosphate, 2-pyrrolidone and other coalescents have been found excellent in improving the films' gloss and leveling properties.

According to the manufacturer, NeoCryl emulsions contain functionally active groups that can react with carboxyls, acid chlorides, acid anhydrides, epoxies, aldehydes, lactones and sulfhydrils that are present in fibers, coatings and films. Other applications, therefore, would include photographic chemicals, coatings for paper, leather and textiles (as antistatic agents). — **Polyvinyl Chemicals Inc., Peabody, Mass. 78B**

Thickening agent

Viscosity of aqueous systems can be increased a hundredfold with new compound.

Experimental Thickener ASE-95 is a milky, acidic (pH 3) liquid of 20% solids content. If you want to thicken a dilute aqueous system in a hurry, this new product will do the job instantaneously.

When ASE-95 emulsion is diluted with water and neutralized with any common base, its solid particles dissolve, the emulsion becomes clear, and the resultant solution undergoes a sudden jump in viscosity. Neutralized after a twentyfold dilution, for example, the resultant solution becomes 100 times more viscous than the original emulsion. Once neutralized, however, the solution cannot revert to emulsion form because a pH reduction below 6 will precipitate the polymer.

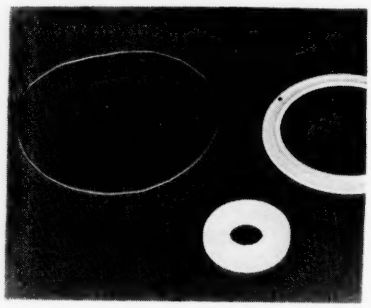
Rohm & Haas describes this thickener as an acrylic emulsion copolymer containing an organic acid, and recommends its use for thickening aqueous and polar-solvent systems such as latex vehicles, pigment suspensions and surfactant solutions commonly found in the paint, paper and coating industries. The company also claims that ASE-95 is an effective suspending agent for pigments, abrasives and finely divided solids.

If the system to be thickened contains enough free alkalinity to neutralize the emulsion, then *in situ* thickening will occur after a slight stirring. This procedure eliminates handling large volumes of dilute, viscous solutions.—**Rohm & Haas Co., Philadelphia. 80A**

Thermoplastic

Familiar resin can now be made as transparent as glass.

Described as crystallizable but never completely crystalline, Kel-F 81 is a new thermoplastic resin whose various degrees of transparency (see photo) or crystallinity depend on its thermal history. The rate of cooling determines crystal growth. When quick-quenched, this resin is commonly known as amorphous. If slow-cooled, it is referred to as crystalline because it becomes a denser, less transparent material, with higher tensile modulus and lower elongation than the optically clear "amorphous" grade.



Formed by homopolymerization of chlorotrifluoroethylene, Kel-F 81 is chemically identical to the existing Kel-F 270 and 300 plastics. But improvements in production methods now provide certain grades of resin that are exceptionally uniform from lot to lot and carefully controlled in molecular weight (two grades are offered with molecular weights of 1,300 and 1,600, respectively.

The most successful applications of this material (valve seats, stems and diaphragms, O-rings, gaskets, printed circuits, rocket engine components) center around its unusual combination of chemical and physical properties. With a thermal stability span of over 800 F., Kel-F 81 remains flexible and tough at cryogenic temperatures, can be molded well above its melting point of 414 F. (compression molding is possible at 500 F.) with little or no degradation to a lower molecular weight chain.

Chemically inert in contact with corrosive acids, fuels and organic solvents, the resin resists deformation and flow at high temperatures and pressures. It also resists abrasion and shows zero moisture ab-

Newsworthy Chemicals

Page number is also reader service code number

Urethane coating dries in humid air....78A
Acrylic emulsions can be formulated in floor polishes....78B
Teflon tape quickens piping assembly....78C
Acrylic thickener boosts viscosity of aqueous systems....80A
Chlorotrifluoroethylene polymer can be made transparent....80B
Sodium borohydride pellets are used as source of hydrogen....82A
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Polyurethane-base sealant offers abrasion and tear resistance....82C
Nickel sulfate hexahydrate may have laser characteristics....82D
Nylon dye has good fastness to light....82E
Benzoyl formic acid and methyl benzoyl formate are available....82F
Bis (tri-n-butyltin) oxide kills marine fouling organisms....82G
Nylon-reinforced plastic can withstand 4,000 F....82H
Rubber extender slashes molding cycle time by 80%....82I
Vinyl plasticizer has high-solvating power....82J
Methyl and ethyl acrylate have low inhibitor content....82K

For more details use Reader Service Card

NEW SLANTS ON HEAT PROCESSING FROM SELAS

Selas to build huge steam reforming furnaces for producing hydrogen

Reaching another milestone of progress in an expanding industry, Selas has been awarded a contract to supply huge, high pressure catalytic steam reforming furnaces, for the production of large volumes of hydrogen. The furnaces will be installed at Tidewater Oil Company's new multi-million dollar Isocracking plant at its Avon, California, refinery.

This new 20,000 barrel-per-day Isocracking plant for upgrading low-valued fuel oils to high octane gasoline, jet and diesel fuels, is being engineered and constructed for Tidewater by Bechtel Corporation.

Selas GRADIATION® furnaces are designed to convert refinery and natural-gas feed into more than 50 million cubic feet per day of hydrogen. Hydrogen will be produced by reacting the gas with steam, over a catalyst, at closely controlled temperatures. The catalyst-containing tubes are heated with DURADIANT® burners, strategically located to achieve the maximum in heat uniformity and temperature control.

Integrated with the furnaces is waste-heat-recovery equipment which generates 124,000 pounds per hour of steam.

Installation of the catalytic steam reforming furnaces will bring to 18 the total number Selas has sold in the past three years for production of hydrogen and synthesis gas for oil refinery use and for the manufacture of ammonia, methanol and oxo-chemicals.

Technical details on the production of hydrogen and synthesis gas are contained in a paper "What's New In Steam Methane Reformers", which was published in April, 1961.

Copies of this paper are available. Write to Fluid Processing Division.

SELAS

HEAT AND FLUID PROCESSING ENGINEERS

DEVELOPMENT • DESIGN • CONSTRUCTION

SELAS CORPORATION OF AMERICA
89 Dreshertown Road, Dresher, Pa.

EUROPEAN SUBSIDIARY: Selas Corporation of America, European Div., S.A., Pregny, Geneva, Switzerland.
INTERNATIONAL AFFILIATES—Australia, Benelux, Canada, England, France, Germany, Italy, Japan, Portugal, Spain.

sorption. — **Minnesota Mining & Mfg. Co., St. Paul, Minn.** 80B

Hydrogen source

Tableted mixture reacts with H_2O to produce gaseous hydrogen.

Wherever you may need low-pressure gaseous hydrogen, you can produce it from a pill—just add water.

A mixture of sodium borohydride and cobalt chloride, Hydripills were first developed as a lightweight hydrogen source for a GE ion-membrane fuel cell to power battlefield radar units. Now, researchers point out to potential users that these same pellets can be used as a hydrogen source for industry.

Originally, researchers reasoned that since nickel boride was an active catalyst for hydrogenation of certain organic compounds, cobalt boride (a product of the Hydripill-water reaction) should be equally active. Hydripills, therefore, should be useful for cleaning up trace impurities in organic products. Trace amounts of water in the product should react to form hydrogen and cobalt boride. The combination would hydrogenate unwanted impurities.

The reaction proceeds as follows:

$$4CoCl_2 + 8NaBH_4 + 18H_2O \rightarrow 2Co_2B + 8NaCl + 6H_3PO_3 + 25H_2\uparrow$$

The cobalt boride precipitates out as a finely divided black solid, catalyzing the further decomposition of sodium borohydride to produce hydrogen.—**Metal Hydrides, Inc., Beverly, Mass.** 82A

Briefs

Molybdenum disulfide makes a good mechanical packing construction when soaked into asbestos yarn. Such a packing, called Moly-Pack, is nonabrasive, noncorrosive, and the molybdenum disulfide adheres well to metal surfaces. In centrifugal applications, it can handle heat to 500 F.; velocity to 800 surface ft./min.; steam pressure to 650 psi.; air, gas and liquids to 2,000 psi.—**Abbott & Biddle, Philadelphia.** 82B

Polyurethane-base sealant, PRC Rubber Calk 3000, is a multipurpose sealing compound of high abrasion and tear resistance. It is reported particularly suited for concrete roadways, bridge abutments, boat decks and hulls.—**Products Research Co., Burbank, Calif.** 82C

Nickel sulfate hexahydrate, grown in large, single crystals may prove to be an excellent window for infrared rays, according to researchers who also market the solution-grown crystals. Available in sizes from 25 g. to over 200 g., the crystals may also have laser characteristics—a subject under current study by the manufacturer. — **Semi-Elements, Inc., Saxonburg, Pa.** 82D

Nylon dye, Supernylite Cerise BL, is being offered as a base color for nylon coloring in the red-violet range. Dyed with the assistance of an acid salt or acetic acid, the product has a good fastness to light. — **Althouse Chemical Co., Reading, Pa.** 82E

Benzoyl formic acid and methyl benzoyl formate are now available in development quantities. Both are slated to be useful as intermediates for pharmaceutical, veterinary and agricultural chemicals. They are structurally similar to chemicals now used in local anesthetics, sunscreening agents, insect repellents, and hair-waving compositions.—**S. B. Penick & Co., New York.** 82F

Bis (tri-n-butyltin) oxide, TBTO, is a new antifouling ingredient in a special paint for boats. Results from various tests have shown TBTO to be toxic to all forms of marine fouling organisms, controlling barnacles, algae, tubeworms, oysters, hydroids and others. This new ingredient is colorless, hence can be mixed with any pigment, is miscible in all common solvents. —**Metal & Thermit Corp., Rahway, N. J.** 82G

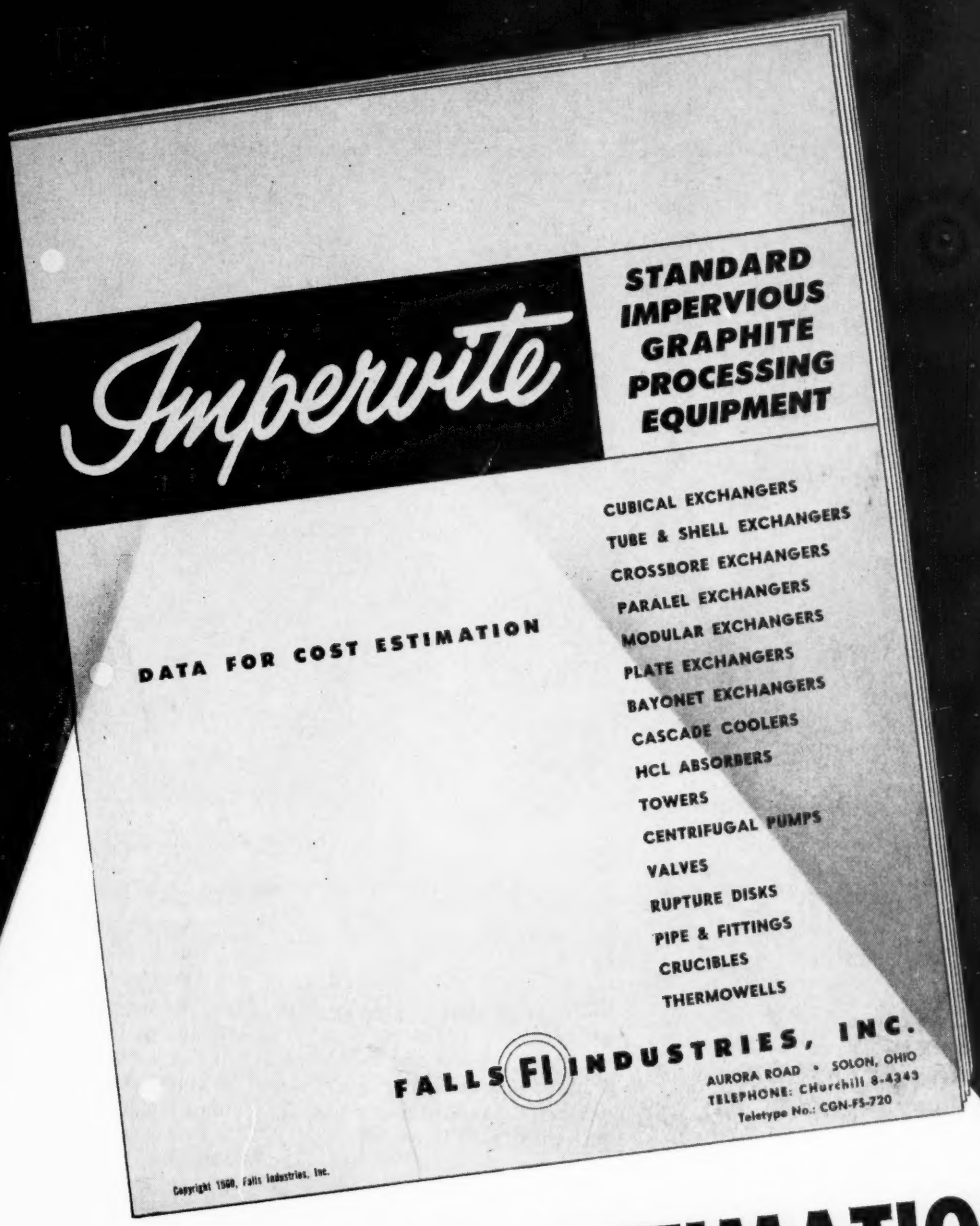
Nylon-base reinforced plastic, Tayloron PN, is a lightweight material (specific gravity 1.20) that may be used for missile components where temperatures exceed 4,000 F. for short periods of time. Made from nylon fabric impregnated with an undisclosed phenolic resin, Tayloron PN has a thermal conductivity of 0.71 Btu./(hr.) (sq.ft.) (°F./in.) at 200 F., is highly machinable and exhibits high deflection under load.—**Taylor Fibre Co., Norristown, Pa.** 82H

Rubber extender called Lipco is a nylon paste with a built-in (but undisclosed) accelerator, said to slash molding cycle time by 70-80%. Miscible with both synthetic and natural rubbers, it has a virtually unlimited shelf life, adds 20-25% more tensile strength, hardness and elongation to the molding mass.—**Long Island Plastics Corp., Lindenhurst, N. Y.** 82I

A new vinyl plasticizer, Flexol RK-1, has been found effective for acrylic lacquers and for films, extruded goods, foam and copolymer resins of vinyl. When used in vinyl-asbestos flooring, Flexol RK-1 offers low asphalt solvation and low migration to rubber, thus minimizing the problems of asphaltor rubber-base adhesives.—**Union Carbide Chemicals Corp., N. Y.** 82J

Methyl and ethyl acrylate are now available with a 15 ppm concentration of monoethylether hydroquinone (an inhibitor). The new grades will shorten polymerization time giving more complete conversion of monomer to polymer. This was not possible with other grades containing 200 ppm or more of inhibitor.—**Rohm & Haas Co., Philadelphia.** 82K

For more information about any item in this department, circle its code number on the Reader Service Postcard (Page 207).



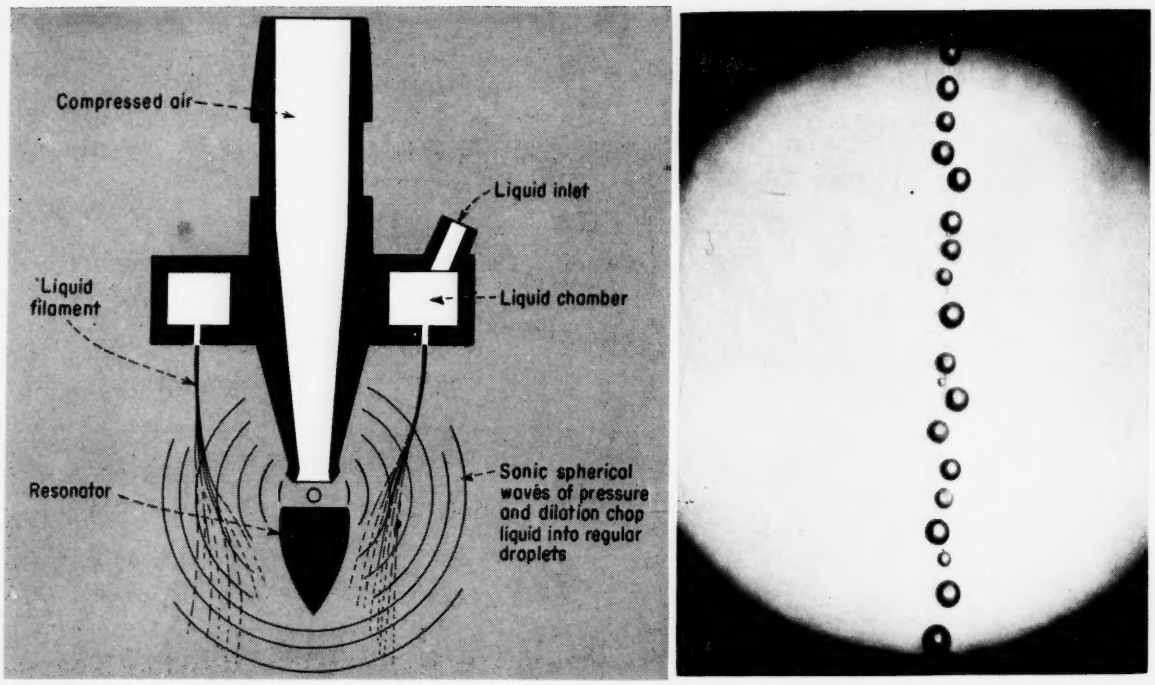
DATA FOR COST ESTIMATION

Falls Industries provides this 32-page report to keep busy processing people up-to-date on the latest designs and costs of impervious graphite processing equipment. Sixteen different types of equipment are covered from Hydrochloric Acid Absorbers and Cross-Bore Heat Exchangers to Rupture Disks and Thermowells. Information supplied includes standard sizes, dimensions and costs.

Because Falls Industries is so active in developing new and improved impervious graphite processing equipment, this cost and standards report is periodically revised. This present report is the third revision since this service was inaugurated. It is available on request to Engineering Department . . .

FALLS FI INDUSTRIES, INC.

Solon, Ohio—CHurchill 8-4343—Teletype No.: CGN-FS-720



SOUND WAVES FORM UNIFORM DROPS IN SPRAY NOZZLE

Nozzle wear is sharply reduced in unit that operates at low pressure, using sonic vibrations to break liquid stream into droplets.

In a new system of spray drying, low-pressure liquid pours out of a header in thin cylindrical streams, is suddenly jolted out of its smooth paths and reformed into a series of uniform droplets. No mechanical operation is performed —the actuating medium is sound.

This is the basis for a new sonic nozzle that offers better control for spray drying in the chemical and food industries, opens new possibilities for processing materials.

▶ **Sonic's Advantages** — The sonic nozzle has several apparent advantages over conventional nozzles because it:

- Operates at low liquid pressure.
- Produces a uniform droplet size.
- Has a long operating life.

Regular nozzles for spray equipment, usually operated at 100-150 psi., have a tendency to wear out at the orifice, resulting in a change in droplet size that may make drying equipment inoperable.

The sonic nozzle, on the other hand, operates at low pressure—atmospheric to 10 psi.—so nozzle wear is practically nonexistent. Hence, the operating life may be extended manyfold over conventional nozzles, which should counteract the higher price and possible lower throughput of the sonic unit.

▶ **Application of Theory**—In spraying technique, the liquid medium is drawn out into thin streams or filaments that succumb to deformation by any minor outside force. The filament necks down at the point of interference, bulges elsewhere, and breaks up into discrete droplets.

Frequently, a secondary set of undesirable smaller droplets is formed from the trailing material between primary particles, producing at least two different sizes of droplets that will have different drying rates and dry to different final moisture contents.

In most nozzles, the filaments and drops are formed by jetting air or gas into the liquid stream, by ejecting the liquid onto a spinning disk, or by whirling it in a small chamber prior to ejecting it from the nozzle orifice.

▶ **Gravity Flow**—In the sonic nozzle, the liquid to be sprayed flows out of a simple manifold chamber through a number of holes, under low applied pressure or the force of gravity.

As the filaments of liquid shower down around a resonator, they are shattered by sound waves at a frequency of about 9,400 cycles/sec. The waves are generated by 15-60 psi. steam or air that cause the resonator tip to vibrate.

In normal spraying, particle size is largely determined by pressure

Relief Map Copyright Aero Service Corp.

BECCO

H_2O_2

A glance at the map is proof that **only Becco supplies Hydrogen Peroxide from so many distribution points.** The practical result is that you can tie up less money in peroxide inventory—without fear of running out. Just make Becco your "warehouse" for H_2O_2 and other peroxygens.

If you buy in drums, you'll get delivery within 24-hours. Bulk shipments, too, are within one-day delivery, if your plant is located in a 500-mile radius of any major Becco distribution point (red dots on the map). But the fact is, whether you are in northernmost Maine or southern-most California—or **anywhere** in between—Becco deliveries are **prompt.**

For the location of your nearest Becco distribution point, write Department CE-61-20.

BECCO Hydrogen Peroxide

Putting Ideas to Work

fmc FOOD MACHINERY AND CHEMICAL CORPORATION

Becco Chemical Division

General Sales Offices:
161 EAST 42nd STREET, NEW YORK 17, N. Y.

forcing the liquid through the nozzle orifice, and by orifice size. Variations in pressure, or erosion of the orifice, can change the spray characteristics of the nozzle significantly.

But according to the manufacturer of the sonic nozzle, air pressure used for sound generation can vary by ±10%, and spray hole-diameter can increase by 100% without an appreciable change in droplet size.

▶**Spray Rate** — Throughput rates of about 6 lb./min. of water have been demonstrated with low-pressure feed vs. up to 50 lb./min. for most conventional nozzles, but the manufacturer states that rates to 60 lb./min. are feasible. Rate can be increased by drilling more holes in the manifold chamber, by making the holes larger or by increasing the pressure. Higher air rates would be needed, of course, but nozzle wear should not become significant.

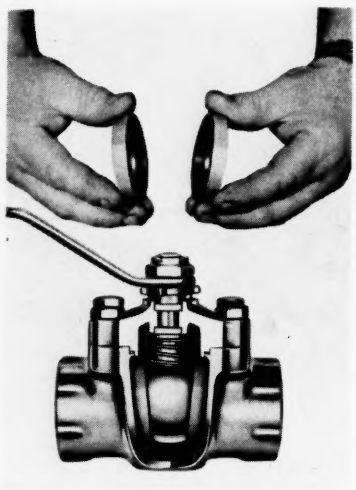
In addition to spray drying, the sonic nozzle can be applied to atomization, prilling, humidification, wetting and cooling. It also serves in defoaming, agglomeration of dust and fumes, emulsification, cleaning, and acceleration of chemical reactions — **Astronics, Inc., Syosset, L.I., New York** 84A

Differential gage

Unit measures pressure drop of 60 psi. at up to 3,000 psi.

Operating by means of a magnetic coupling that eliminates the possibility of leakage, this differential pressure gage has an accuracy of ±2% in the temperature range from −40 to +200 F. It measures differentials to 60 psi. at a working pressure of 3,000 psi.

Standard materials of construction are aluminum and nickel alloys; other materials are available on request.—**Pall Corp., Glen Cove, N. Y.** 86A



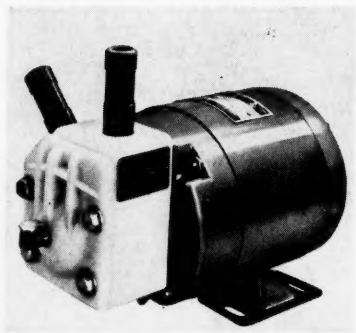
Ball valve

Special seats extend operating temperature from 600 to 1,000 F.

Special seats permit use of ball valves at temperatures to 1,000 F. when handling nonoxidizing gas or liquids, and to 700 F. with oxidizing materials. Metal-reinforced Teflon seats are usually not good at much higher than 600 F.

Maximum pressures obtained at elevated temperatures depend on the valve body material. Type 316 stainless steel bodies with a 300-lb. ASA rating can withstand 355 psi. at 1,000 F.; the same design in carbon steel is good to 80 psi. Higher pressures can be obtained at lower temperatures—the 300-lb.-rating bodies can be used for 490 psi. at 700 F.

Use of the nonresilient seats, called Graphitar, is made possible by a nonflexing, nontorsional spring that forces the ball downward into a wedge-seat arrangement. Valve with screwed or socket weld-end connections comes in 1-3-in sizes. — **Hills-McCanna Co., Carpentersville, Ill.** 86B



Plastic sealless pump

Rotor, turning on eccentric shaft, progressively squeezes soft liner.

Pumping is accomplished by a rotor on an eccentric shaft that turns within a flexible liner with this plastic pump that has no stuffing boxes, shaft seals, valves or gaskets. Fluid trapped between the liner and body block is progressively squeezed through the pump at capacities from ⅓ to 10 gpm. at pressures to 35 psi.

Designed for original equipment applications on plating equipment, for lube oil service, bottle fillers and laboratory equipment, the unit may also have applications in pilot-plant and production service.

Standard materials are high-temperature neoprene for the liner, and linear polyethylene for the body block. Other materials such as PVC, Buna N, Kel F and Hypalon are available on special order.

Pump is self-priming, operates wet or dry, and can handle slurries or viscous materials. — **Vanton Pump & Equipment Corp., Hillside, N. J.** 86C

Flow meter

Metal-tube construction extends temperature and pressure range.

A variable-area flow meter now comes in metal-tube construction, making it suitable for handling hazardous materials and for service at temperatures and pressures beyond the range of glass-tube models.

The meter features interchange-

able floats that may be used to increase the capacity in steps equal to 20% of the previous range. Water capacities range from 1 to 400 gpm., air capacities from 4.2 to 1,680 std. cu. ft./min. Tube dia. is ½ to 3 in.

Standard unit has a magnetic indicating extension; if desired, it may be equipped with a transmitter to operate recorders, controllers or integrators. The follower ring travels in a precision-bore glass tube sealed with O-ring gaskets to eliminate dust and prevent fogging and corrosion.

The meter may be rotated 360 deg. to match outlet piping.—**Wallace & Tiernan, Inc., Belleville, N. J.** 86D

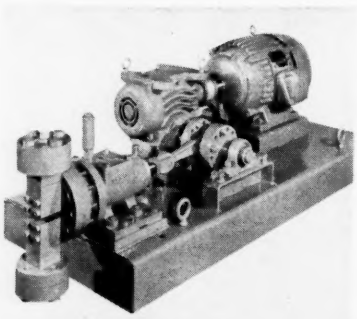
Batch mixer

Rotating-drum unit uses standard 5-gal. pail as mixing container.

Stirring, blending, folding or tumbling of liquids, powders, granular materials, slurries, doughs and pastes is accomplished by a rotating drum mixer with a stationary removable paddle that scrapes sides and bottom of the container.

Any standard 5-gal. steel pail can be used for a mixing drum; many materials may be mixed directly in their shipping containers. An adaptor holds 1-gal. cans, if desired.

Easily transportable, the 55-lb. unit needs no fastening down during operation. The drum carriage may be tilted to seven different positions for best mixing of various materials.—**KOL, Inc., St. Paul.** 88A



Diaphragm pump

High-pressure unit can handle corrosive slurries at 3,000 psi.

Specifically designed for handling corrosive slurries at up to 3,000 psi., a newly designed diaphragm pump employs an actuating fluid between the piston and the diaphragm, without any mechanical linkage. All surfaces of the pump that contact the pumped medium are of Teflon and inert metals.

A cast steel, water-cooled housing is available for high-temperature applications. The unit contains prelubricated bearings and an adjustable stroke for variable volume. Capacity ranges from 1.5 to 6 gpm.—**Keystone Engineering Co., Houston, Tex.** 88B

Self-priming pump

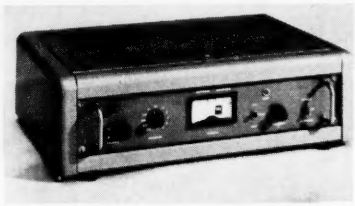
Fluid is pumped by flexible impeller rotating in eccentric chamber.

Available in bronze for general-purpose pumping and in stainless steel for sanitary service, this self-priming pump has a many-vaned neoprene impeller rotating in an eccentric chamber. As impeller rotates, space between vanes becomes smaller as vanes approach discharge. Squeezing action provides continuous, uniform discharge flow.

Bronze model will produce a suction lift of 10 ft. when dry, 20 ft. when primed. Capacity ranges from 6.5 gpm. at 2.2 psi. to 3.2 gpm. at 13 psi. Mounted at any angle, the unit works from 45-160 F.

For sanitary service in the areas of foods, beverages and pharmaceuticals, the stainless steel model is available in capacities of 10, 25, 50 and 100 gpm. Suction lifts are 15 ft. when dry, 25 ft. when primed. Output is to 50 psi.

Both pumps will handle slurries containing solid particles, without damage to the pump. The impeller is lubricated by the material being pumped.—**Jabsco Pump Co., Costa Mesa, Calif.** 88C



Electronic integrator

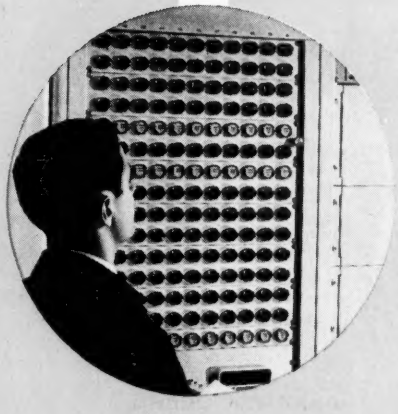
It computes value of integral and records the results on a bar graph.

Designed for use with any standard servo-drive recorder, an electronic integrator is especially suited for use in gas chromatography. It not only automatically computes the integral of a chromatogram, but records it in bar graph form, using the same pen on the same strip chart as the original recording.

Integration can be started or stopped, manually or automatically, for periodic integral presentations. To minimize the effect of noise and baseline drift, a threshold control is provided so

New Equipment continues on page 182

For more information about any item in this department, circle its code number on the Reader Service Postcard (Page 207).



PROCESS PROTECTOR

Hagan AIM—centralized monitoring of all important variables

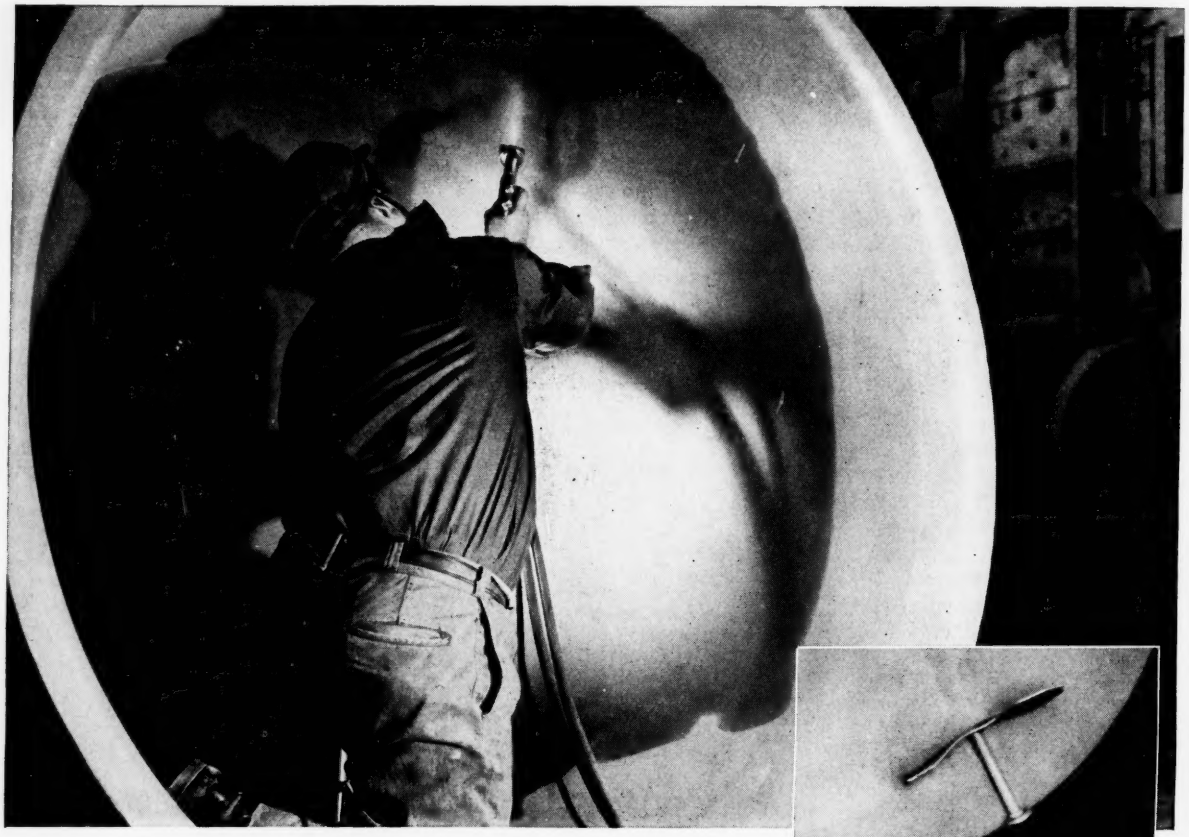
Temperatures, pressures, flows, levels, closures, in fact any input that can be represented by DC voltages as low as 10 millivolts full scale can be monitored by the Hagan AIM (Alarm Indicating Monitor) with an accuracy of plus or minus 0.1% full scale.

Fast and reliable, the Hagan AIM is compact—for example, the readout and alarm panel for 200 alarm points will fit into a 19″ x 47¼″ panel area. Combining all alarm functions in one instrument, AIM can be set for high or low alarm points, or both. Seconds after a monitored variable goes out of bounds, AIM energizes the alarm light and sounds a warning horn. The horn can be shut off, but the light stays lit until the condition is corrected. AIM safeguards both equipment and process from the shattering damage that a single runaway variable can produce. Now *one* man can watchdog a complete process line, taking corrective action before damage is done.

AIM is one component of the complete Hagan line of process controls, which include primary elements, transducers, controllers, recorders and final control elements. Designed for use with existing installations or for complete new systems, the Hagan line can save you money in terms of more accurate control with minimum adjustment and maintenance. For information, write or phone HAGAN CHEMICALS AND CONTROLS, INC., Hagan Center, Pittsburgh 30, Pa.

HAGAN

PENTON* at work: PFAUDLON 301



The modern corrosion barrier for process tankage

Pfaudlon 301 is the name of a water-suspension coating based on Penton which provides an economical way to protect equipment from the corrosive effects of direct product contact with corrosive fluids and atmospheres.

Resistant to more than 300 different chemicals and chemical reagents Pfaudlon 301-Penton coatings are hard, nonporous, glossy and smooth. They can be readily applied as an interior or exterior coating to such metals as mild steel, cast iron, stainless steels, Hastelloys, brass, bronze or copper.

Pfaudlon 301 coatings can serve on many kinds of equipment—storage tanks, open vessels, hoods, blowers, ducts, baskets, pump and pump parts.

Pfaudlon 301-Penton coatings can be supplied by Pfaudler on new process equipment, or applied on existing equipment as a custom coating by Pfaudler-licensed applicators in your area.

Pfaudlon 301 coatings are but one of the many ways in which Penton, the modern engineering thermoplastic, is now serving industry in combating corrosion of many types. Penton processing components of all types are now readily available. Write for your copy of "The Penton Buyer's Guide," a complete listing of suppliers of valves, pipe and fittings, pumps, meters, tank linings and coated parts made with this low cost, durable, and reliable corrosion barrier.

Pfaudlon 301 Stays On: Penton-coated agitator used to mix highly abrasive sandlike slurry in 3½% of 37% HCl in H_2O shows no visible corrosion after twelve months of steady production.

Simple as ABC. Send for The ABC's of Penton for Corrosion Resistance. *This bulletin rates Penton's performance at temperatures up to 250°F. when exposed to over 300 chemicals and reagents.*

**Penton is the Hercules Powder Company registered trademark for chlorinated polyether.*

HERCULES POWDER COMPANY
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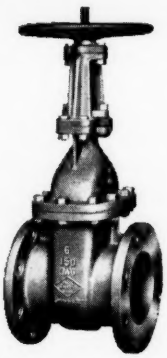
Hercules Tower, 910 Market Street, Wilmington 99, Delaware

QP61-5

For information on Pfaudlon 301 coatings for new or existing process equipment, write: Pfaudler Permutit, Inc., Rochester, New York.



In this **Split Wedge Gate**

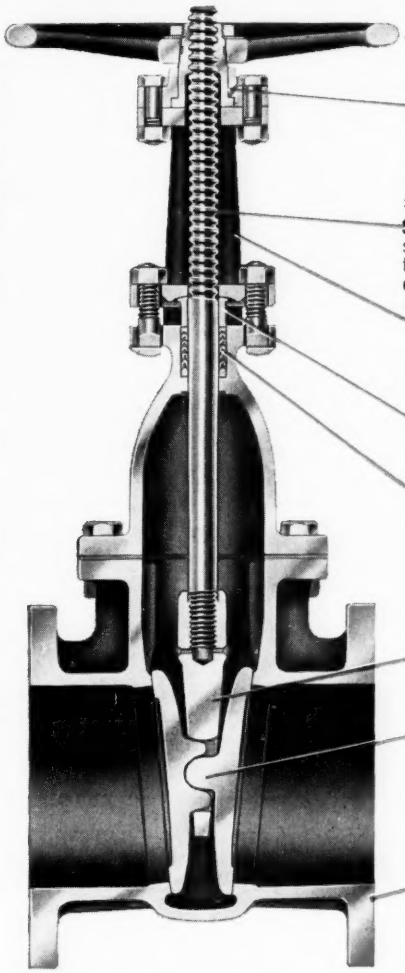
you can see why it pays to

Specify JENKINS for STAINLESS STEEL Valves, too

This picture shows the many points of excellence in the design and construction of Jenkins Fig. 1327 Split Wedge Stainless Steel Gate Valves. Compare them with any valve you know. You'll conclude that it's hard to beat Jenkins at making valves, no matter what the material.

But no picture can show the quality of the castings . . . the precision machining . . . the rigid inspection and testing that have gone into this valve. All of these are as important as design and metal alloys in assuring long, dependable, economical valve service. And, all of them are up to the peak standards for which Jenkins has been known for almost a century.

SEND FOR NEW CATALOG of Jenkins Stainless Steel Valves. You'll find in it the patterns you want, in a choice of alloys that satisfy the requirements of practically all corrosive services. Also, you'll see that these Jenkins valves meet valve industry specifications and the high standards established by the leading users of stainless steel valves. **Jenkins Bros., 100 Park Avenue, New York 17.**



WHEEL of high strength malleable iron designed for firm grip and easy operation.

YOKE BUSHING, easily renewable. Made of bronze, for ideal thread engagement with stainless steel spindle, to prevent seizing or galling of spindle threads. Bushing of stainless steel is optional.

SPINDLE has long thread bearing surfaces with correct lead for easy, tight closing. Screws into wedge carrier, then secured by a stainless steel pin.

YOKE BONNET has liberal space between yoke arms for easy access to packing box. Precision machined flange face assures uniform contact with gasket for a tight body-bonnet joint.

GLAND consists of two pieces — gland flange and gland follower — eliminates binding of follower in case gland bolts are tightened unevenly.

PACKING of Chevron-type Teflon in large packing box prevents leakage. Only a minimum load is required on gland, extending service life of packing.

WEDGE CARRIER connects wedge to spindle and raises or lowers it. Husky in size to stand any operating strains.

SPLIT WEDGE is the ball-and-socket design which automatically adjusts to the tapered seating surfaces for positive shutoff. The discs, revolving freely in the wedge carrier, produce a self-cleaning action on seating surfaces and reduce possibility of galling and seizing.

BODY —Through-port design for full, free flow. Ample wall thickness and good design provide extra strength to withstand stresses. End flanges conform to M.S.S. specs.

JENKINS

LOOK FOR THE JENKINS DIAMOND

VALVES

JENKINS SINCE 1864

Jenkins Bros.

Sold Through Leading Distributors Everywhere

JENKINS BROS., 100 Park Avenue, New York 17, N. Y.

☐ Send the new stainless steel valve catalog

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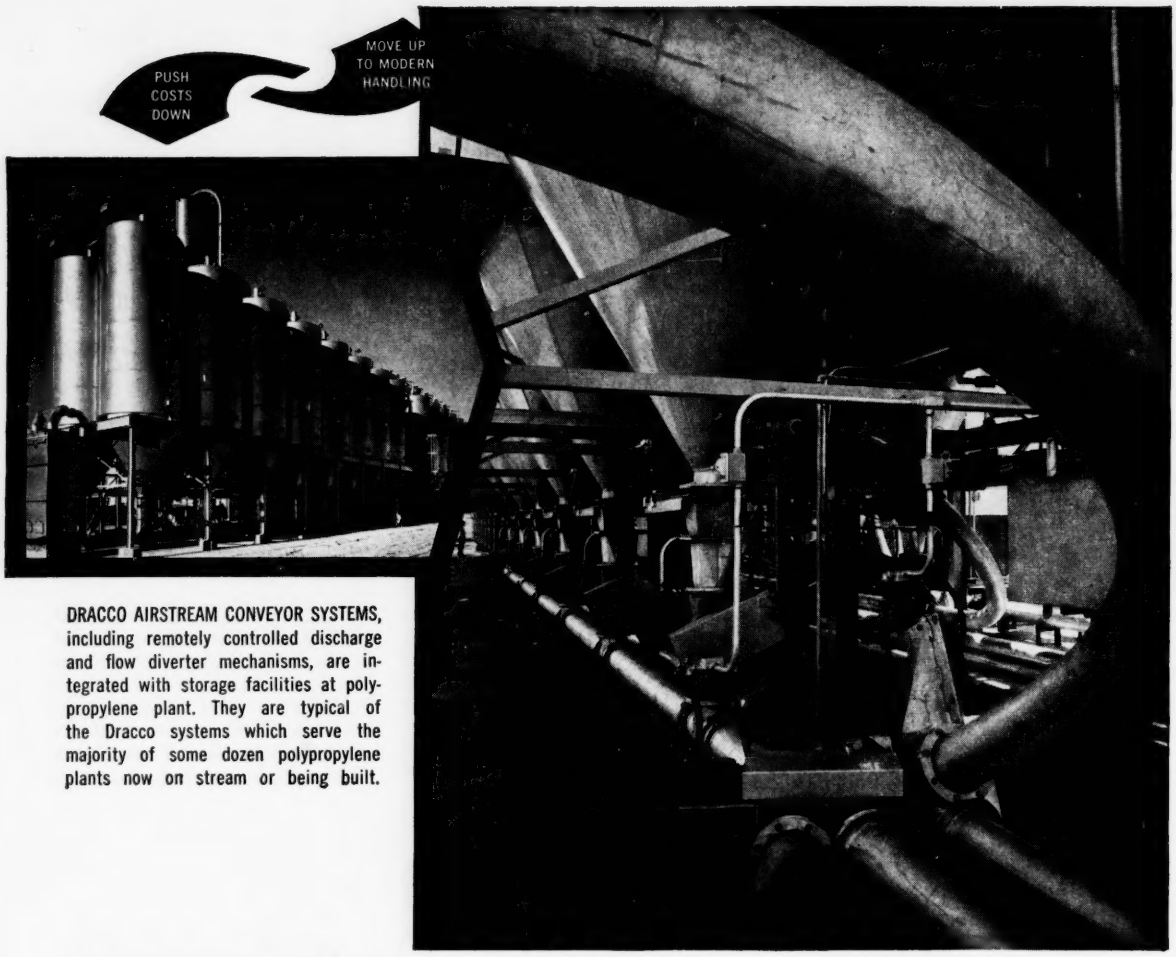


DRACCO AIRSTREAM CONVEYOR SYSTEMS, including remotely controlled discharge and flow diverter mechanisms, are integrated with storage facilities at polypropylene plant. They are typical of the Dracco systems which serve the majority of some dozen polypropylene plants now on stream or being built.

handling polypropylene

. . . a job for specialists in air conveying

Polypropylene is trying to crack the highly competitive plastics market. Success depends on lowering production costs through advanced methods and equipment such as automatic, through-process bulk handling.

Handling polypropylene is a Dracco specialty, developed through unequaled experience in air conveyor engineering for producers of other petrochemical-based plastics. For example, some 80 per cent of the nation's polyethylene plants are equipped with Dracco Airstream Conveyor Systems. Now, most polypropylene producers are looking to Dracco for bulk handling as modern as their new product.

Dracco engineers are at home in the special areas of knowledge required for a true "systems" approach to bulk handling problems in these plants. This is applied in comprehensive conveyor networks that can move materials from dryers through process to storage and bagging or bulk loading.

Low-cost, programmed handling is accomplished with centralized automatic control. Materials flow smoothly on an enclosed stream of filtered air or inert gas . . . without dust, waste, discoloration or contamination. Systems may be expanded easily, with minimum engineering, when handling requirements increase.

Why not place *your* bulk handling problems in the hands of specialists? Call or write: Dracco Division of Fuller Co., Harvard Avenue & East 116th Street, Cleveland 5, Ohio.

See Chemical Engineering Catalog for details . . . or write for 32-page Bul. 530, "Dracco Airstream Conveyors."

DRACCO *airstream* conveyors
dust control equipment

FULLER COMPANY GENERAL

Shell has three benzene-producing refineries, located near waterways. Barges like these will carry the bulk of 1961's record output.

BULLETIN:

Shell has increased benzene production to meet your rising needs—capacity now exceeds 80 million gallons per year

Shell has increased its benzene production nearly 500 percent in less than 18 months. Shell's benzene-producing capacity in the U. S. is now the largest in the world.

Shell's stepped-up output comes to you via a nationwide supply network served by 3 refineries.

Read how Shell's increased benzene production can help you meet your rising benzene requirements now.

WITH DEMAND for benzene at an all-time high, and with new uses coming along each year, Shell is producing more benzene now than ever before.

Bigger supplies now

Shell has stepped up production of benzene again. Shell's capacity has already topped 80 million gallons of high purity benzene. *And Shell has nationwide facilities for producing and distributing benzene.*

Widest distribution

Shell Benzene is produced at three refineries. At Wood River, Illinois; Houston, Texas; and Wilmington, California.

NOTE: All three refineries are located near waterways. You can take delivery of Shell Benzene in barges, in tank cars and transport trucks. Deliveries can come direct from the refinery.

Manufacturers choose Shell Benzene when precise control is vital. Its quality is consistently high.

And it is free of Thiophene.

For full facts on Shell Benzene, contact your Shell Industrial Products Representative. Or write: Shell Oil Company, 50 West 50th Street, New York 20, N. Y.

SHELL

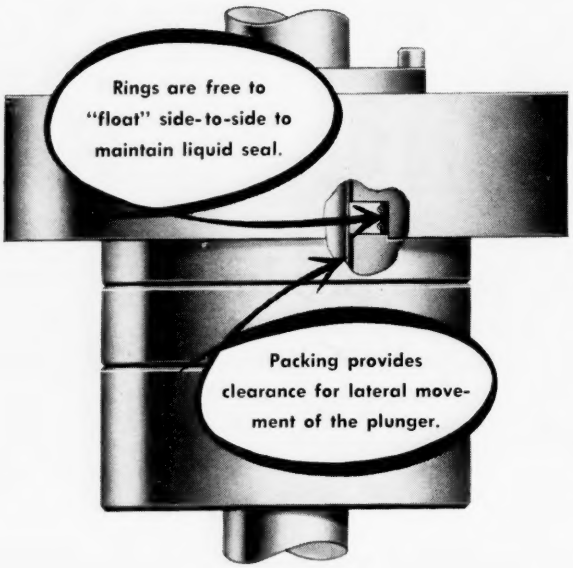
A BULLETIN FROM SHELL
—where 1,997 scientists are working to provide better products for industry

ENGINEERING

NEWS YOU CAN USE ABOUT ENGINE AND COMPRESSOR PERFORMANCE

THIS LIQUID-PUMP PACKING ACTUALLY FLOATS TO ELIMINATE COSTLY LEAKAGE PROBLEMS

Cook's special full-floating, self-adjusting packing boosts performance, reduces downtime of high-pressure plunger pumps



Plungers of all liquid pumps tend to "run out of true." As a result, conventional packings must make room for this lateral movement with a clearance around the plunger. Thus, a path is soon formed and excessive leakage occurs. This leakage can be reduced by adjustment but soon starts again.

To eliminate this annoying and expensive packing problem, Cook has designed a special liquid-pump packing which has proved itself in a number of varied field applications. This Cook packing actually *floats with the movement of the plunger*. It doesn't have to make room for the "run-out" of the plunger—it simply moves with it!

Cook packings are now successfully handling all types of liquids—oil, water, chemicals, brine, etc.—under many special operating conditions. These self-adjusting packings now make possible trouble-free performance without frequent adjustments. They are adaptable to all new or existing pump designs and become part of the permanent pump assembly. Ask a C. Lee Cook representative to give you the details about this special liquid-pump packing.

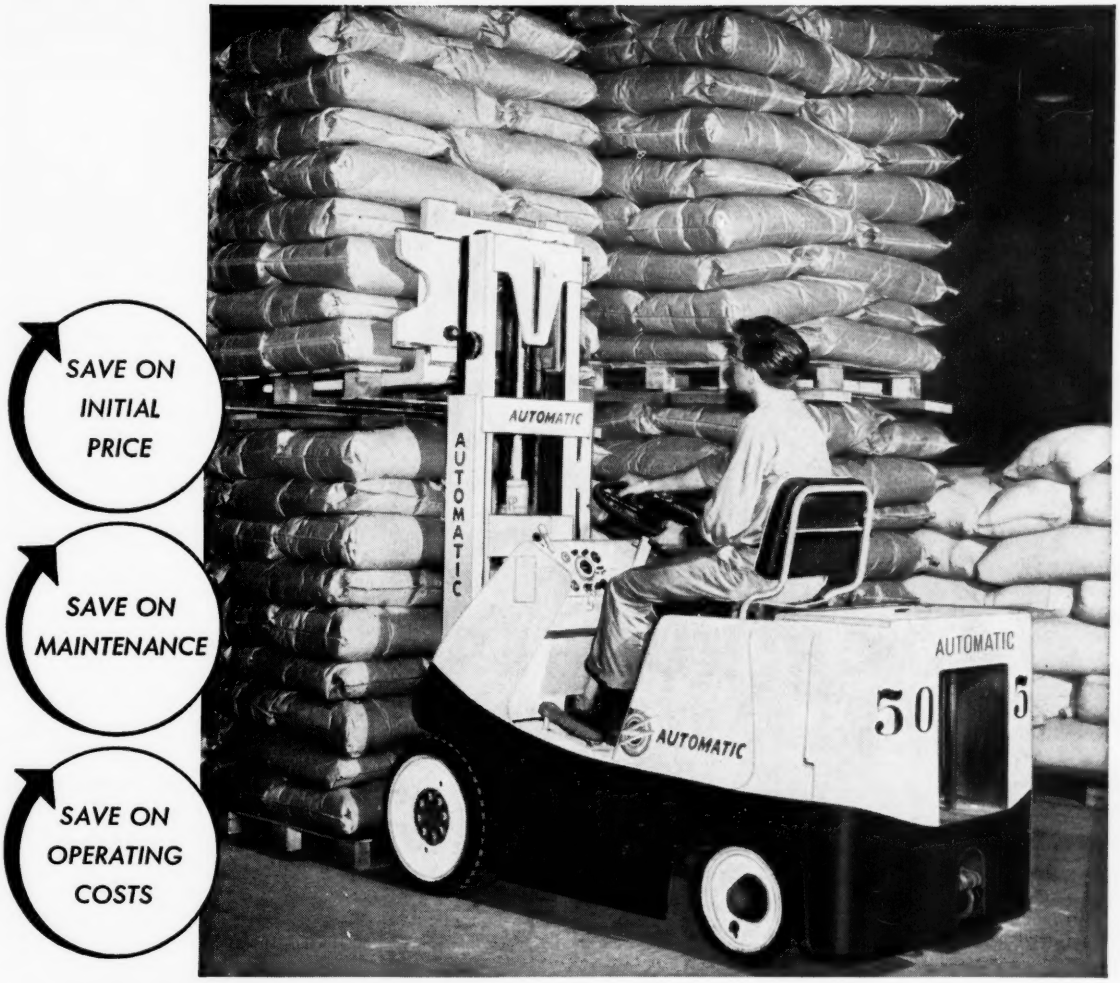
WRITE FOR MORE INFORMATION

If you want Cook engineers to review the special requirements of your specific liquid-pump packing application, just send the necessary details to C. Lee Cook Division, Dover Corporation, 958 South Eighth Street, Louisville 3, Kentucky. Or send for complete information about any of Cook's complete line of rings and packings.

COOK SEALS LIQUIDS AT EXTREME PRESSURES AND TEMPERATURES

C. Lee Cook has unique experience in the advancement of liquid-seal technology. Recently completed research and development contracts (one with a major airframe and missile manufacturer) have resulted in new concepts of seal design, materials compatibility, friction limitations and sealing efficiency. If yours is a special packing application, call in a Cook representative.

C. LEE COOK
DIVISION OF DOVER CORPORATION
Rings and Packings Since 1888



EASE THE PROFIT SQUEEZE WITH AN AUTOMATIC® GAS LIFT TRUCK

A truck that's down for repairs costs plenty. So does one that gulps fuel. AUTOMATIC's answer: a truck with no clutch to shift or wear out, no complicated torque converter to breakdown . . . a truck that saves you up to 30% on fuel . . . and yet costs no more to buy.

With as many as 200 fewer wearing parts compared to conventional power shift units, the danger of unexpected downtime is practically eliminated. So is the cost of complex and frequent repairs. An AUTOMATIC *gas* truck means less maintenance . . . easier maintenance.

Cutting fuel bills, while at the same time increasing output, is another profit-saver. AUTOMATIC's high efficiency transmission gives higher torque while moving more tonnage per hour with less fuel.

Check initial cost. AUTOMATIC's gas lift truck is priced competitively to all other trucks of the same capacity equipped with automatic transmission.

It's a sound formula to combat the profit squeeze: save on initial cost, save on maintenance, save on operating costs.

Capacity with cushion rubber tires, 3000 to 10,000 lbs., pneumatic tires, 3000 through 8000 lbs.

AUTOMATIC

AUTOMATIC TRANSPORTATION COMPANY
Division of The Yale & Towne Manufacturing Company
155 West 87th Street, Dept. H1, Chicago 20, Ill.

FIRST IN IMAGINATION
FIRST WITH REALITY

WRITE FOR DESCRIPTIVE LITERATURE

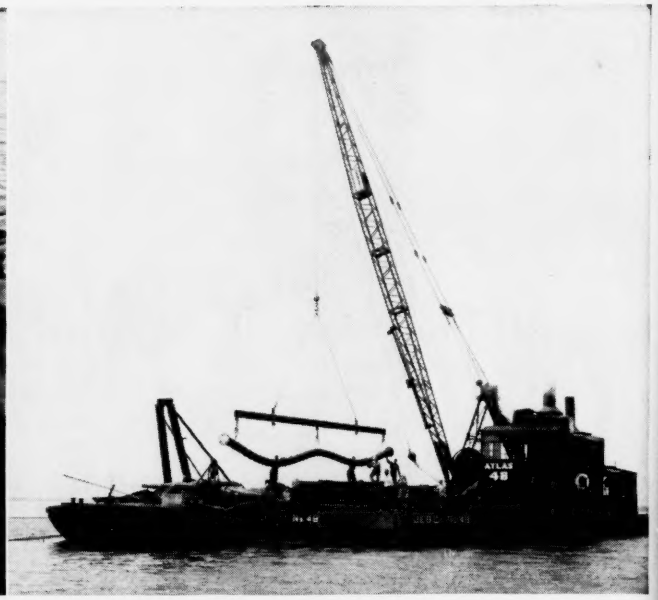
Please send full details on Automatic Gas-Operated Lift Trucks:

Name_____

Firm_____

Address_____

City_____ Zone_____ State_____



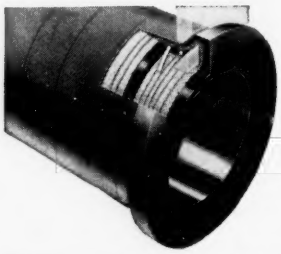
CONDOR RUBBER PIPE used for

Largest Under-Water Waste Disposal System

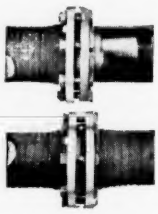
A large chemical plant has installed 1864 feet of 12″ diameter Condor Flexible Rubber Pipe in the lower Delaware River to discharge process wastes from shore to the river channel. Condor Rubber Pipe provided flexibility to permit bolting 50′ lengths together on the deck of the dredge and laying them into a trench in the river bottom. This was easier than bolting or welding a metal pipe-line under water . . . and the rubber pipe will last longer than metal against salt water corrosion outside; nitric and sulfuric acid wastes inside.

Condor Flexible Rubber Pipe outlasts steel 3 to 10 times. It is made in types to withstand pressures up to 250 psi. Installation is easy, economical—and there's no danger of leaky joints at pipe bends. New Hydro-Lok built-on flanges offer full sealing surface *plus* advantage of sure alignment and easy rotation of pipe to equalize wear—*without* removing flange bolts.

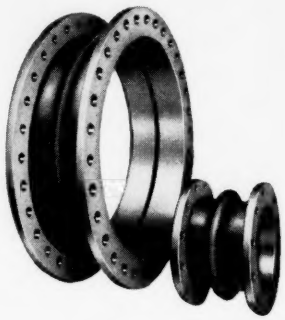
Let an R/M representative give you details on Condor Flexible Rubber Pipe . . . or write today for Bulletin 7152.



- Steel Pressure Ring molded into Hydro-Lok Flange
- Thick, corrosive resistant tube
- Multiple plies of heavy duck
- Reinforcing spiral of steel spring wire
- Tough durable cover



Hydro-Lok Flanges may be used with equal ease to couple rubber pipe to iron pipe with standard flanges (top) or existing sections of rubber pipe using other flanges.



R/M RUBBER EXPANSION JOINTS

- Overcome Pipe Expansion Stress
- Avoid Piping Misalignment
- Resist Abrasion and Corrosion
- Offer Maximum Resistance to Shock
- Require No Gaskets

RM 1008

RAYBESTOS-MANHATTAN, INC.

MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

RM

ENGINEERED RUBBER PRODUCTS ... MORE USE PER DOLLAR

"a solid reliability record"

"A VIGOROUS USERS EXCHANGE ORGANIZATION"

"unmatched capability in its price class"

"WIDEST SELECTION OF INPUT-OUTPUT ACCESSORY UNITS"

"PROGRAMMING SUPPORT IN DEPTH"

"EASE OF USE!"

WITH THE BENDIX G-15 COMPUTER YOUR EXTRA DIVIDEND IS EXPERIENCE

There's a reason for the continuing leadership of the Bendix G-15 among small and medium-scale computers. The reason is *experience*... for over five years... in nearly 400 installations... in more than 1000 different applications.

Behind this experience is superior performance, real economy, and proven support... qualities which have made the G-15 preferred by thousands of engineers in industry after industry.

The G-15 achievement record is outstanding. It continues to be a leader in its field—the number of new G-15 users is growing every month. Investigate the proven capabilities of the G-15 today. See for yourself why G-15 "experience pays"... and how it can work for you. • *For information on your particular applications write to:*

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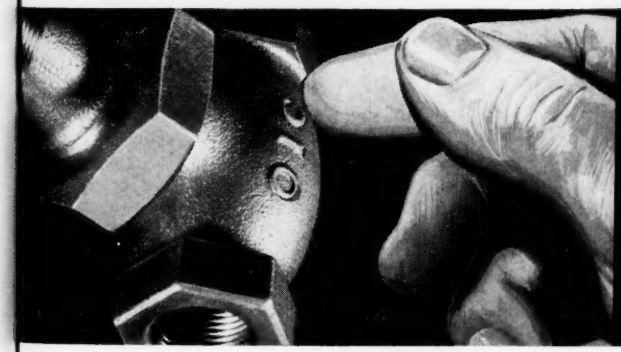
THE Bendix CORPORATION

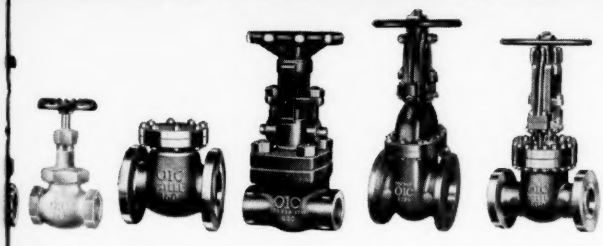
MEN WHO SPECIFY VALVES...

HEAR MORE ABOUT OIC VALVES!

SEE MORE AND MORE OIC VALVE INSTALLATIONS!



INSIST ON OIC FOR ALL VALVE APPLICATIONS!



You pay no premium for quality when you specify O I C. Special emphasis on design and manufacture . . . frequently in excess of industry specifications . . . assures you complete operational reliability, long life, reduced maintenance and easy access to vital working parts. A nation-wide distributor organization is ready and willing to advise you on the best valve for your particular application.

OIC VALVES

BRONZE, IRON, FORGED STEEL, CAST STEEL AND DUCTILE IRON VALVES

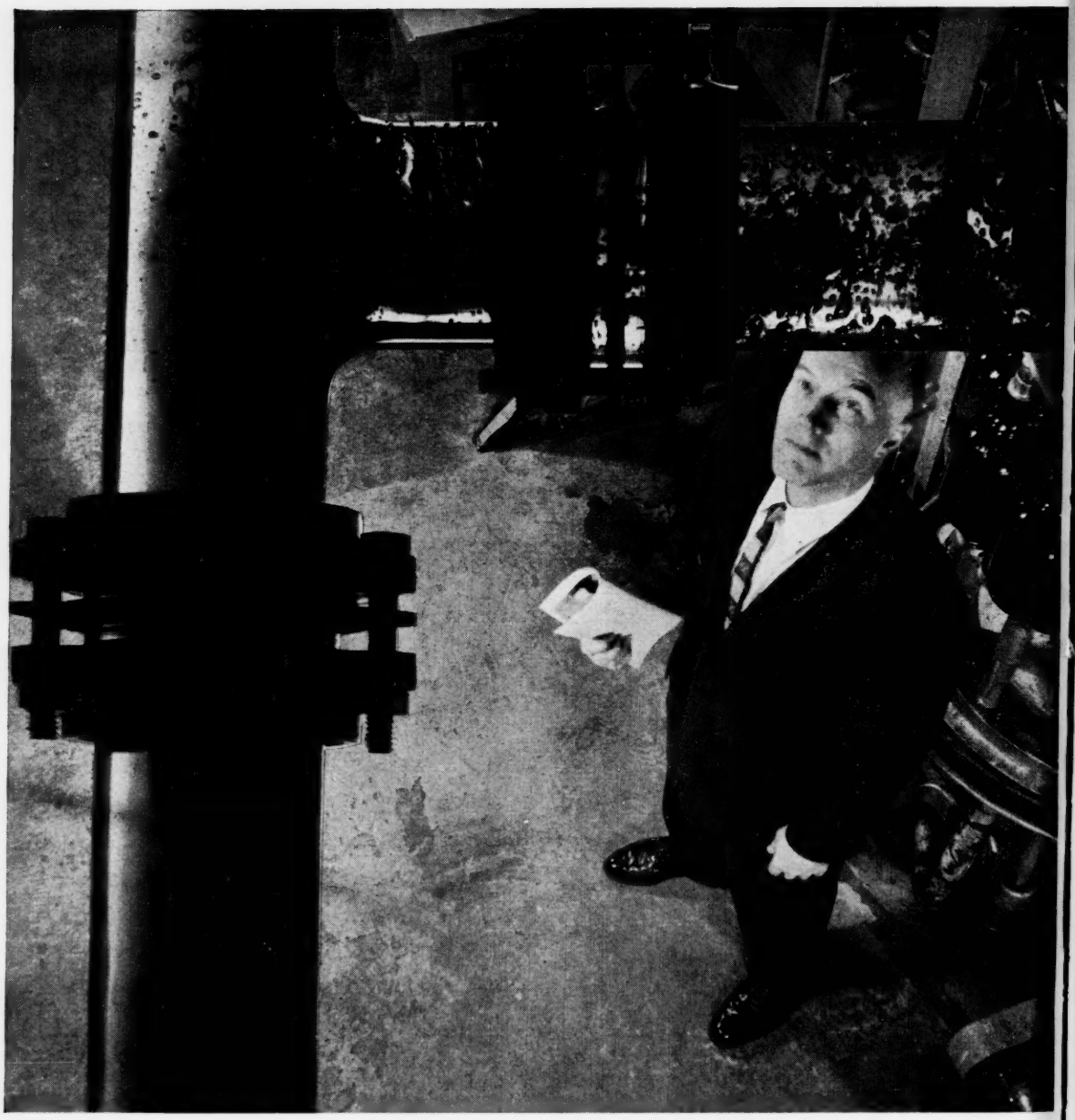
INDUSTRIAL DISTRIBUTORS — SERVING INDUSTRY ECONOMICALLY — THE RIGHT HAND OF PRODUCTION

THE OHIO INJECTOR COMPANY, WADSWORTH, OHIO

10816-OIC

The Ohio Injector Company
263 Main Street, Wadsworth, Ohio.
O I C quality is essential to my operations. Please send me complete information.

Name _____
Company _____
Product _____
Street _____
City _____ Zone ___ State _____



Corrosion is licked here . . . why quit when you're ahead?

You may be using PYREX® pipe now for your most corrosive applications.

Think about putting it to work wherever you carry *any* corrosive liquid, or fluids that must go through without contamination.

Put these advantages in every line: Low installed cost that repays itself quickly in maintenance and replacement savings, in reduced down time. Chemical inertness that prevents corrosion and contamination. Thermal shock strength that lets you pump through hot-cold-hot. Transparency that makes easy maintenance even easier, allows for constant visual inspection of flow.

PYREX pipe throughout will give you room to move, too. Switch line applications as you will, knowing every line can handle anything you put in it.

Write to Plant Equipment Department, 8909 Crystal Street, Corning, N. Y. for our Bulletin PE-3. It gives you full details.

CORNING GLASS WORKS
CORNING MEANS RESEARCH IN GLASS

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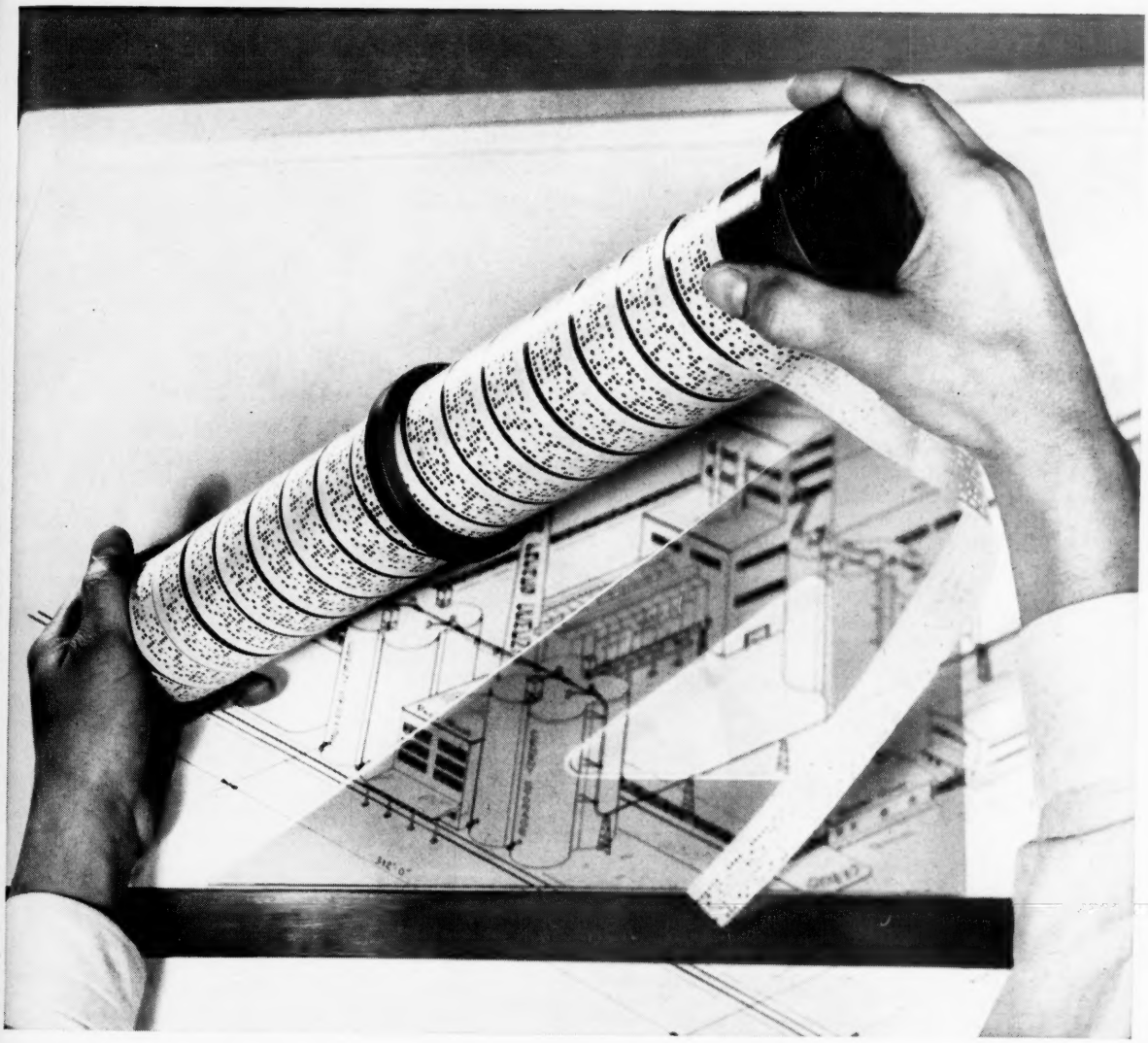


Traylor designs a multitude of kilns by computer

. . . to make sure you get the one design that's best for you

Before the kiln you order gets into metal—before it even reaches the drawing board—Traylor engineers develop from their computer the preferred design variations appropriate to your requirements, including maintenance.

Stored on punched paper tape is the knowledge and experience of many engineers over many years. Months of calculations are done in days or hours. Traylor engineers are freed from routine and repetitive computations for the more creative task of *evaluation* . . . determining which of the almost infinite combinations of vital variables will assure you the best kiln design, the highest thermal efficiency not only of the kiln itself but of auxiliary equipment, too.

The Traylor computer is programmed to solve many major problems in addition to basic kiln design . . . including clinker cooler air and heat balance, dew point of kiln exhaust gases, analysis of kiln heat and air flow.

Through its own facilities and those of Fuller Company, Traylor brings to bear on your kiln problems a breadth of process know-how long recognized by industry as unexcelled.

Call in Traylor early in your plans. Write outlining your requirements. Traylor experience is at your service. Literature is available on request.

See Chemical Engineering Catalog for details and specifications.

Traylor — FULLER COMPANY — GENERAL

TRAYLOR ENGINEERING & MANUFACTURING

DIVISION OF FULLER COMPANY

1551 MILL STREET • ALLENTOWN 1, PA.

4170
TKA-14


Son, we call this
a "Fisher"

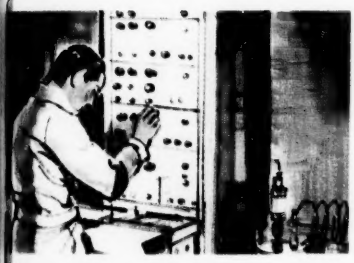
The worthiness of a name

In refineries, chemical plants, and oil fields, many "old timers" associate the name "Fisher" with high quality control valves and liquid level controllers. Through the years, in their work on instruments and controls, they have come to know that "Fisher" means dependability.

"Put a 'Fisher' in the line, and forget it." they would always say.

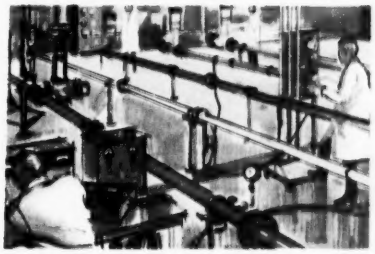
The quality found in Fisher equipment lies not only in metal and fiber and paint. It is also found in the practical design, manufacturing techniques, and the rigid inspection program. These high quality factors along with outstanding research and engineering facilities assure you of trouble-free performance. Throughout the world, "Fisher" means dependable control equipment.

FISHER GOVERNOR COMPANY *Marshalltown, Iowa / Woodstock, Ontario / Rochester, England*

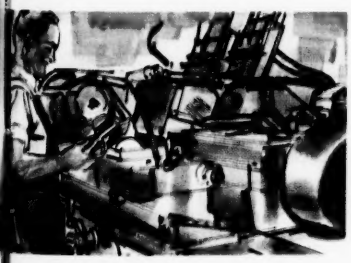


ntinuous Advanced Research . . . Fisher search maintains a continuous program for velopment and use of new metals and ma- rials to meet the increasingly severe nditions, encountered daily, in the nuclear d cryogenics fields.

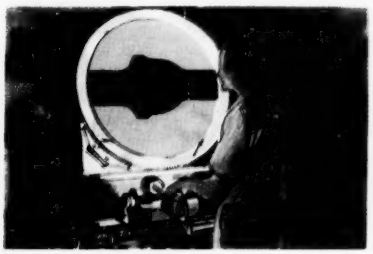
Engineering and Research . . . Almost three-fourths of Fisher's 41 graduate engineers have more than 10 years service . . . a total of 380 years experience in design engineering aimed at solving industry's flow control problems, practically and efficiently.



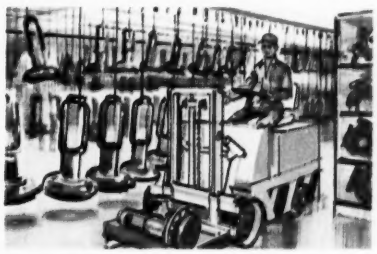
Testing and Development . . . Representative of the very latest and finest in equipment that aids Fisher engineers in the development of new and improved products is the recent addition of a test line that is capable of handling air or water pressures up to 2,500 psi.



test Production Methods . . . Various new yle grinders produce a super-finish on sher valve guides and bushings, second to ne in the industry. It is typical of precision anufacturing methods that assure long, ouble-free operation of Fisher controls.



Rigid Inspection Procedures . . . The highest ratio of inspection personnel to production personnel in the industry is maintained at Fisher. As an example, there are no less than 704 inspection operations on a 4" Type 657-A diaphragm control valve.



Efficient and Fast Service . . . "Supermarket" 36-hour delivery, from the factory, on popular sizes and types of controls is only one of many services available to Fisher customers. Seventeen sales offices throughout the country maintain field stocks for immediate delivery.

If it flows through pipe anywhere in the world ...chances are it's controlled by.....

FISHER® Controls SINCE 1880

B&W's NEW FITTINGS PLANT IS IN FULL OPERATION

YOU GET FITTINGS AND FLANGES MADE BY ENGINEERS FOR ENGINEERS

Take B&W Orifice Flanges for Instance: Piping Engineers commonly refer to an Orifice Flange as the "Cash Register" of the piping system. Metering has to be precise . . . never varying. To accomplish this, these "cash registers" have to be *engineered* to permit accurate measuring . . . year after year after year. B&W Orifice Flanges have been designed and engineered to do just this. Take a look at some of the features. Compare them with the flange unions you're now using.

1. Extra long bolts to permit insertion of all orifice plates and gaskets and still have ample threads for proper bolting. Semi-finished hex nuts exceed specifications.
2. Plugs are precision made (not cast) and machined from same material as flange. Plug hole is chamfered for easy plug insertion.
3. Metering hole is a true 180°. Tolerances are near perfect. Hole is packed with grease to reach you in finest possible condition.
4. Jack bolts are "man-size" — won't twist off or bend under pressure. Machined jack bolt slot acts as wrench lock.

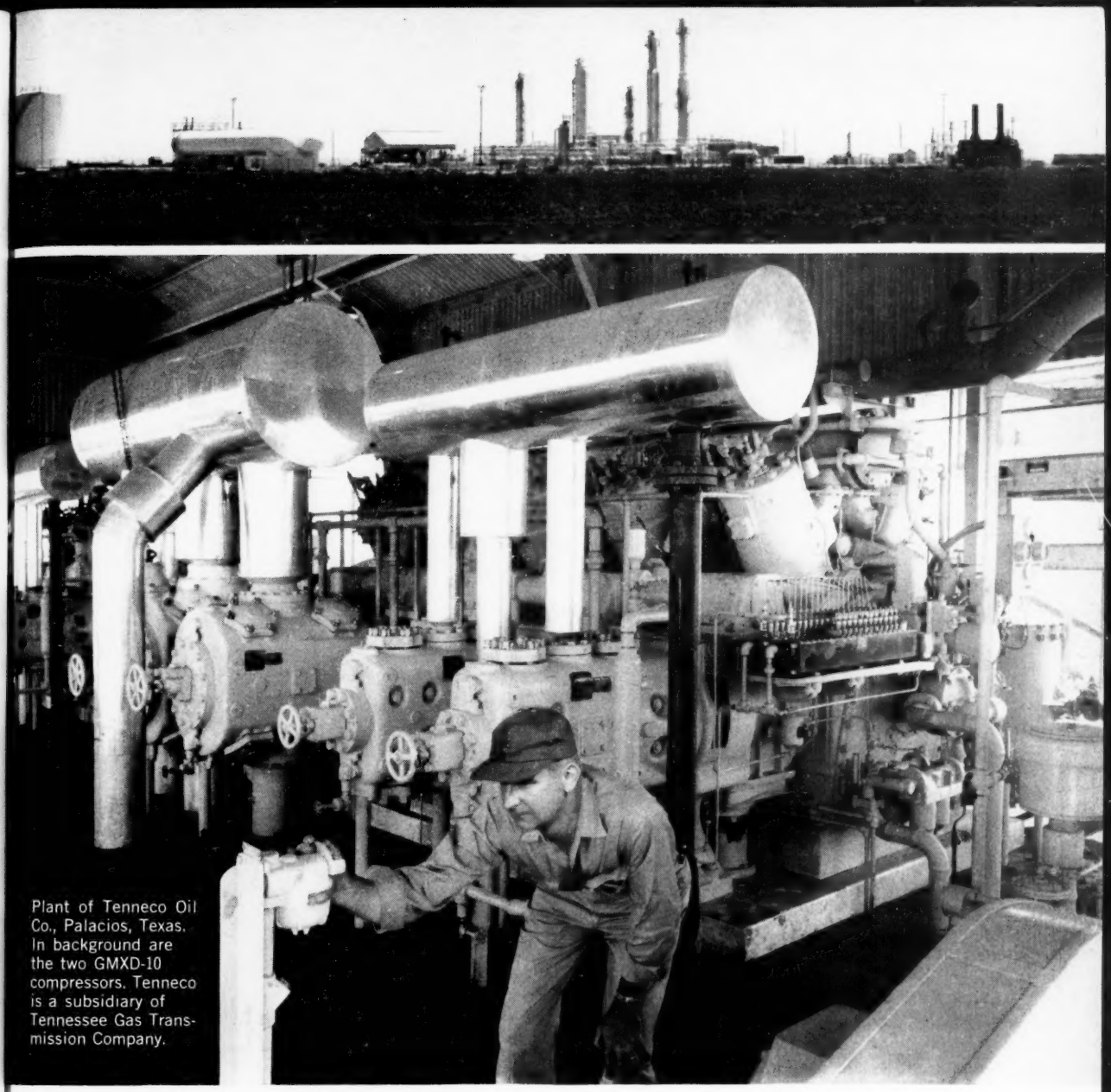
B&W, at their new Fittings Plant in Beaver Falls, is now producing "engineered" Orifice Flanges. For further information on type and sizes available, write for B&W Bulletin TF-507 or contact any B&W District Sales Office. The Babcock & Wilcox Company, Tubular Products Division, Fittings Plant, P. O. Box 230, Beaver Falls, Pennsylvania.

B&W THE BABCOCK & WILCOX COMPANY

TA1022WF5

TUBULAR PRODUCTS DIVISION

Seamless and welded tubular products, solid extrusions, rolled rings, seamless welding fittings and forged steel flanges — in carbon, alloy and stainless steels and special metals



Plant of Tenneco Oil Co., Palacios, Texas. In background are the two GMXD-10 compressors. Tenneco is a subsidiary of Tennessee Gas Transmission Company.

Compressors handle heavy load in low-temperature processing

Compression facilities of the new Tenneco Oil Company plant at Palacios, Texas, were designed for 55 mmcfd. Its two Cooper-Bessemer compressors are now handling 70 mmcfd, 'round the clock.

This low-temperature oil-absorption processing plant went on stream January, 1961, and soon reached, then surpassed its rated capacity. It will soon be expanded to 90 mmcfd.

Its two 660 hp Cooper-Bessemer GMXD-10 compressors, shown above, are giving exceptional service under these severe conditions. Each unit has two stages in refrigeration for processing and two stages in booster service for returning gas to supply lines.

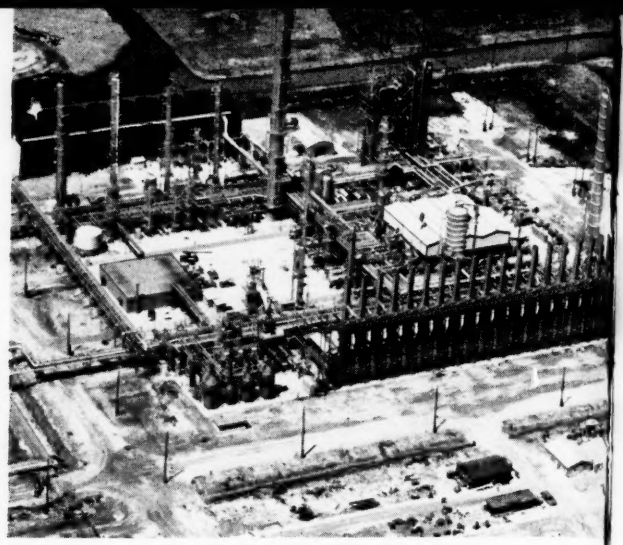
Find out how the complete line of Cooper-Bessemer products can assure peak performance for *your* compression or power facilities.

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

COMPRESSORS · RECIPROCATING AND CENTRIFUGAL
ENGINES · GAS · DIESEL · GAS-DIESEL
JET-POWERED GAS TURBINES

Process Flowsheet



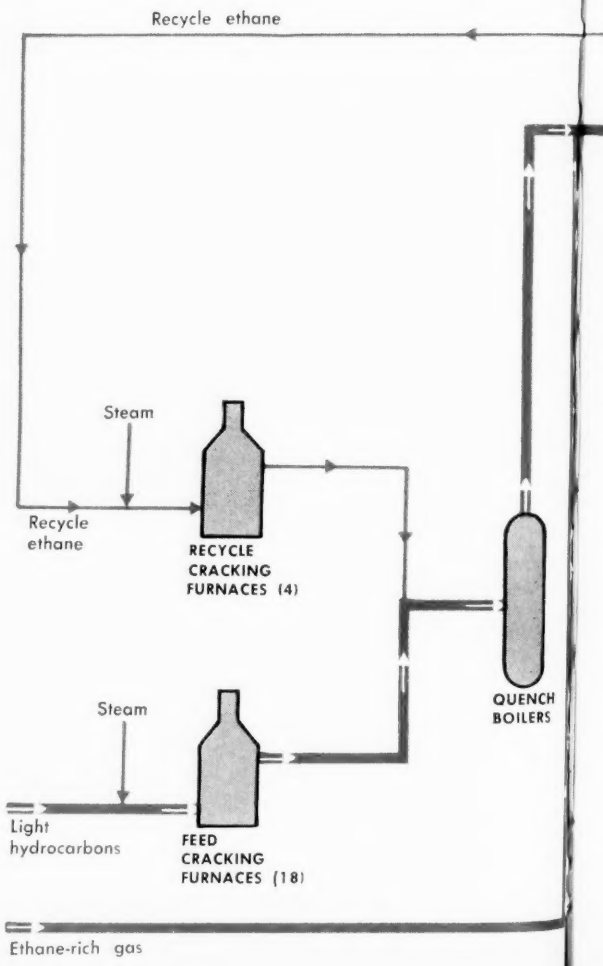
First Petrochemical Step a Big One

Formed a little over a year ago, Mobil Chemical Co. has for its first facility an ethylene plant said to be the largest in operation. And the product is 99.9+% pure.

Newly formed Mobil Chemical Co. has been both bold and basic in its first petrochemical venture.

At Beaumont, Tex., this summer, the Socony Mobil Oil Co. subsidiary placed on stream an ethylene plant described as the largest in the world. It turns out 99.9+% ethylene at a 380-million-lb./yr. clip, as well as 200 million lb./yr. of polymerization-grade propylene, and 45 million lb./yr.

T. H. ARNOLD, JR.
Southwestern Editor



Unfold flowsheet

of butadiene that exceeds polymerization specifications.

In line with ethylene's status as the cornerstone for petrochemical synthesis, the new unit is the first plant of an eventual large complex that the firm contemplates for the area. Next step, due for completion late this year, will be a 30-million-gal./yr. benzene unit.

And, three customers for Mobil's current output have already come into the Beaumont vicinity with plants due on stream this year. Houston Chemical Co. will make tetraethyl lead, tetramethyl lead and ethylene glycol from Mobil-supplied ethylene. Foster Grant Polyolefins Co. will also buy ethylene, for polyethylene manufacture. And a Goodyear Tire & Rubber Co. polyisoprene and polybutadiene plant will receive propylene and butadiene.

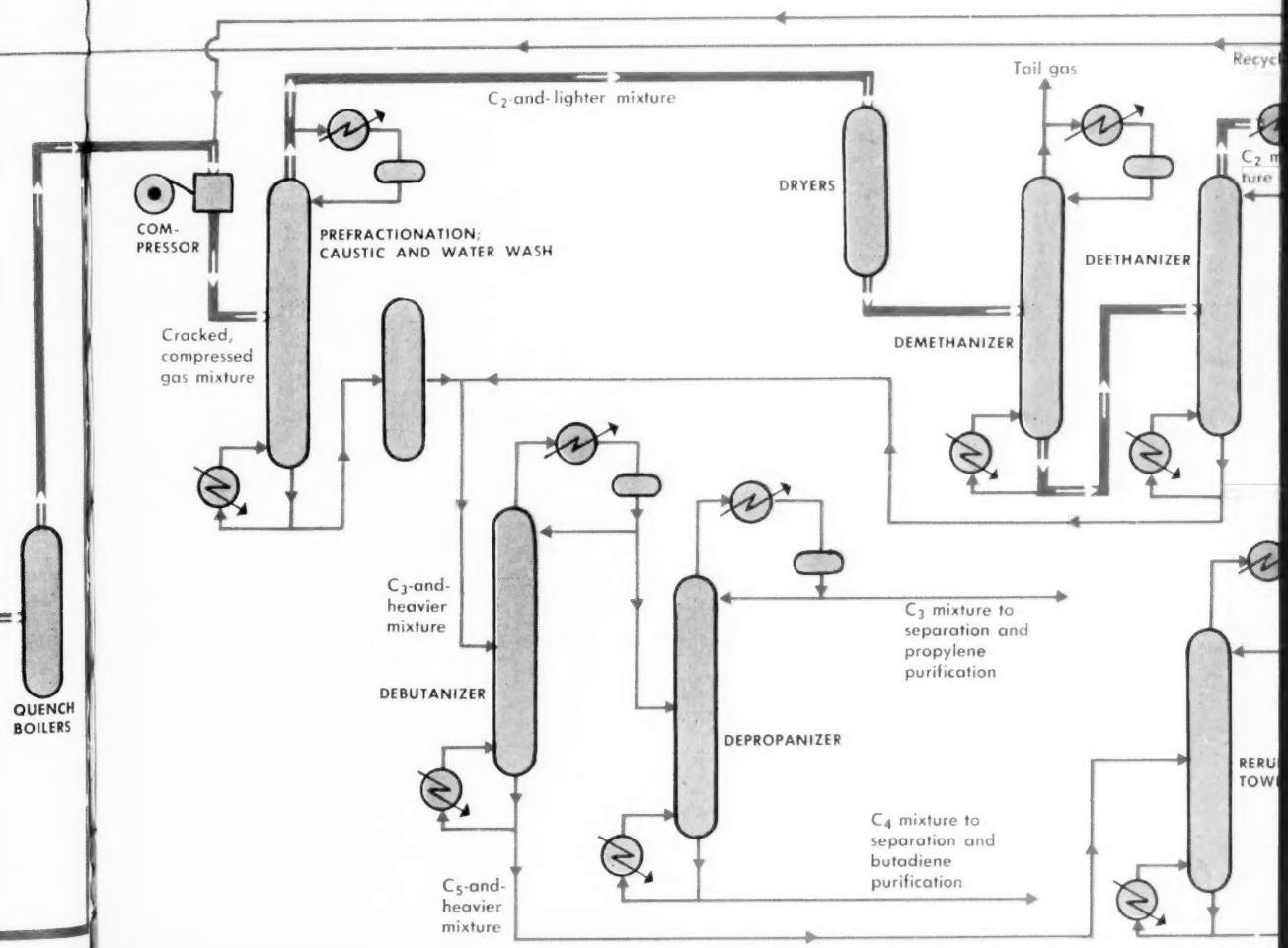
Plant size and product purity aren't the only features of Mobil's new facility. The company follows a new trend in ethylene production, feeding the unit not only the customary ethane-rich gas but also a "light hydrocarbons" liquid stream. Feed amounts to 1,400 moles/hr. of the former, 18,600 bbl./day of the latter.

These numbers cannot be compared directly because stream compositions are not disclosed. But it is almost certain that the liquid makes up over half the charge on a weight basis.

Built by M. W. Kellogg Co., the unit blends both conventional and new features in ethylene technology. The flow diagram shows the general processing sequence.

▶**First Steps**—An undisclosed feed-preparation step reduces the light hydrocarbons stream from 18,600 to 14,600 bbl./day. Steam is added, and the mixture goes to a bank of 18 feed-cracking furnaces.

Furnace effluent cools to about 700 F. in quench boilers that generate 400-psi. steam. The cracked, cooled stock blends with the ethane-rich feed gas and with methane-rich recycle from ethy-



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W. Kellogg Co., the unit blends
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a bank of 18 feed-cracking

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at generate 400-psi. steam. The
tock blends with the ethane-rich
methane-rich recycle from ethy-

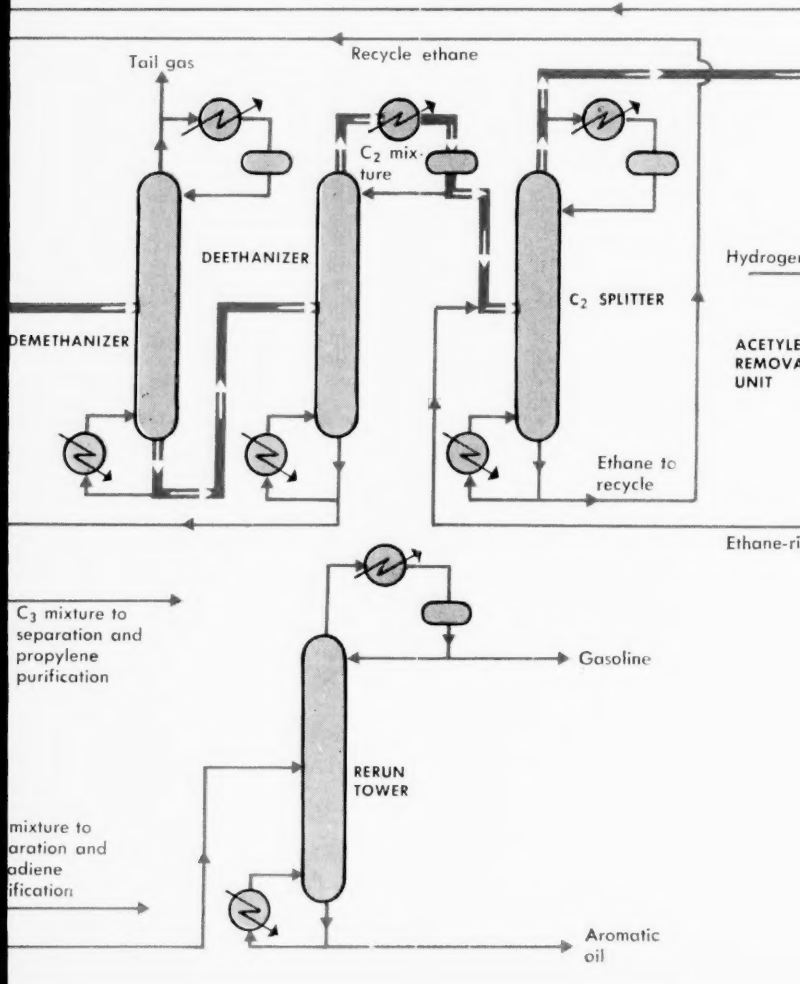
lene purification. This mixture is co
passes to caustic-and-water wash
tionation operations that split the
heavy and light streams.

▶ **Heavy Products**—The propyle
fraction is separated in three tower

The first is a debutanizer, whic
and heavier components as bottoms
goes to a rerun tower that yields
gasoline and 700 bbl./day aromatic

Material from the top of the de
to a depropanizer, which produces
and C_4's as bottoms. Each of these
to its own purification process, and t
is 2,800 bbl./day propylene, 1,200
pane, 700 bbl./day butadiene and
butylenes. Butadiene purification
extraction.

▶ **And Ethylene**—The ethane-and-li
produced during prefractionation a
first dried, then goes to a deme



ixture is compressed, then
vater wash and prefrac-
at split the mixture into
.

ne propylene-and-heavier
three towers.

nizer, which removes C_5's
as bottoms. This stream
hat yields 3,300 bbl./day
y aromatic oil.

op of the debutanizer goes
h produces C_3's overhead
ach of these streams goes
ocess, and the final output
lene, 1,200 bbl./day pro-
diene and 1,100 bbl./day
urification is by furfural

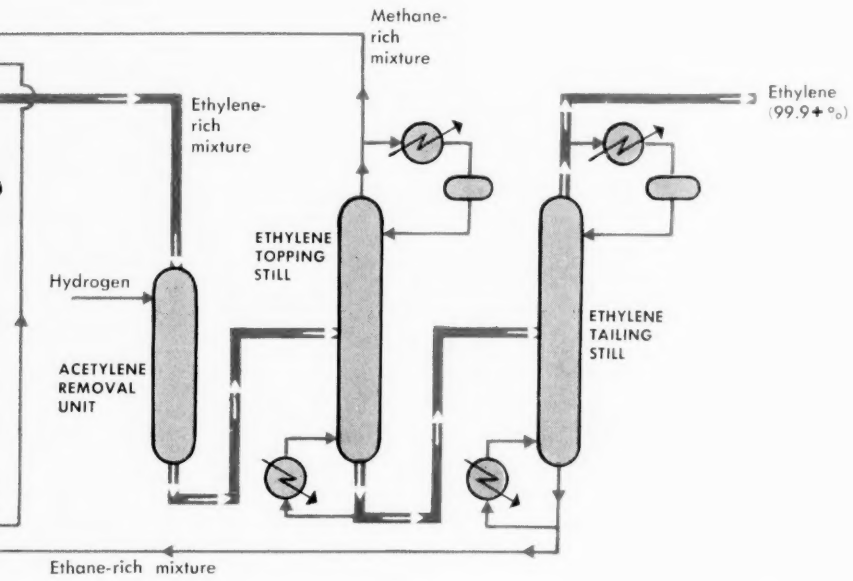
thane-and-lighter fraction
tionation and washing is
to a demethanizer. De-

methanized bottoms, in turn, enter a deethanizer that removes residual propylene and heavier material.

Overhead C_2 mixture from the deethanizer goes to a C_2 splitter that separates ethane as bottoms. This stream is routed to the beginning of the process, where it is blended with steam and fed to four recycle-cracking furnaces. Output combines with the effluent from the 18 feed-cracking furnaces.

Meanwhile, C_2 olefins mixture from the splitter goes to acetylene removal. For this step, Mobil uses a Dow Chemical Co. selective hydrogenation process.

Final ethylene purification takes place in topping and tailing stills. Former removes methane overhead; the latter takes out ethane as bottoms. Product ethylene is compressed to about 1,200 psi., then goes to a pipeline delivery system. To assure a continuous supply to Mobil's customers, the system contains underground storage cavities.



MIX-MULLER®

MEANS CONTROLLED DISPERSION

. . . AT NORTH AMERICAN REFRACTORIES COMPANY

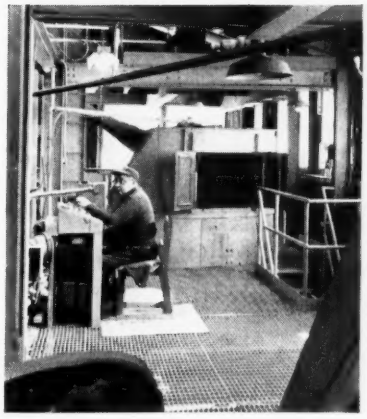
Automation speeds processing, guards product uniformity.

No guesswork goes into the batch preparation and blending operation at North American's Curwensville, Pa., fire brick plant.

High above the press floor, two No. 3 Mix-Mullers are programmed to blend and disperse just the right amount of moisture and dry fire clay mix on a cycle carefully calculated to deliver a continuous flow of material to the presses. A central control panel permits flexibility of operation; saves time, labor and affords full and effective use of raw materials.

No guesswork went into North American's choice of mixers for this important operation either! As longtime Mix-Muller users, North American engineers selected Simpsons for their easy adaptability for automatic charge, discharge and cycling . . . as well as for Mix-Muller's proven ability to develop optimum pressing and firing characteristics for quality refractory products.

If you mix dry solids in this age of better and *more expensive* raw materials . . . can you afford to settle for *less* than *controlled* dispersion?



Dale Kephart controls dry press batch preparation and mixing operations at the Curwensville plant from National *"Time Master"* control panel.

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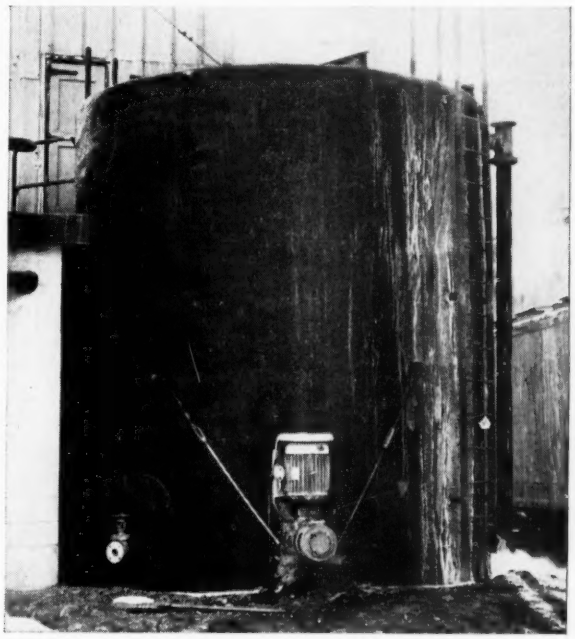

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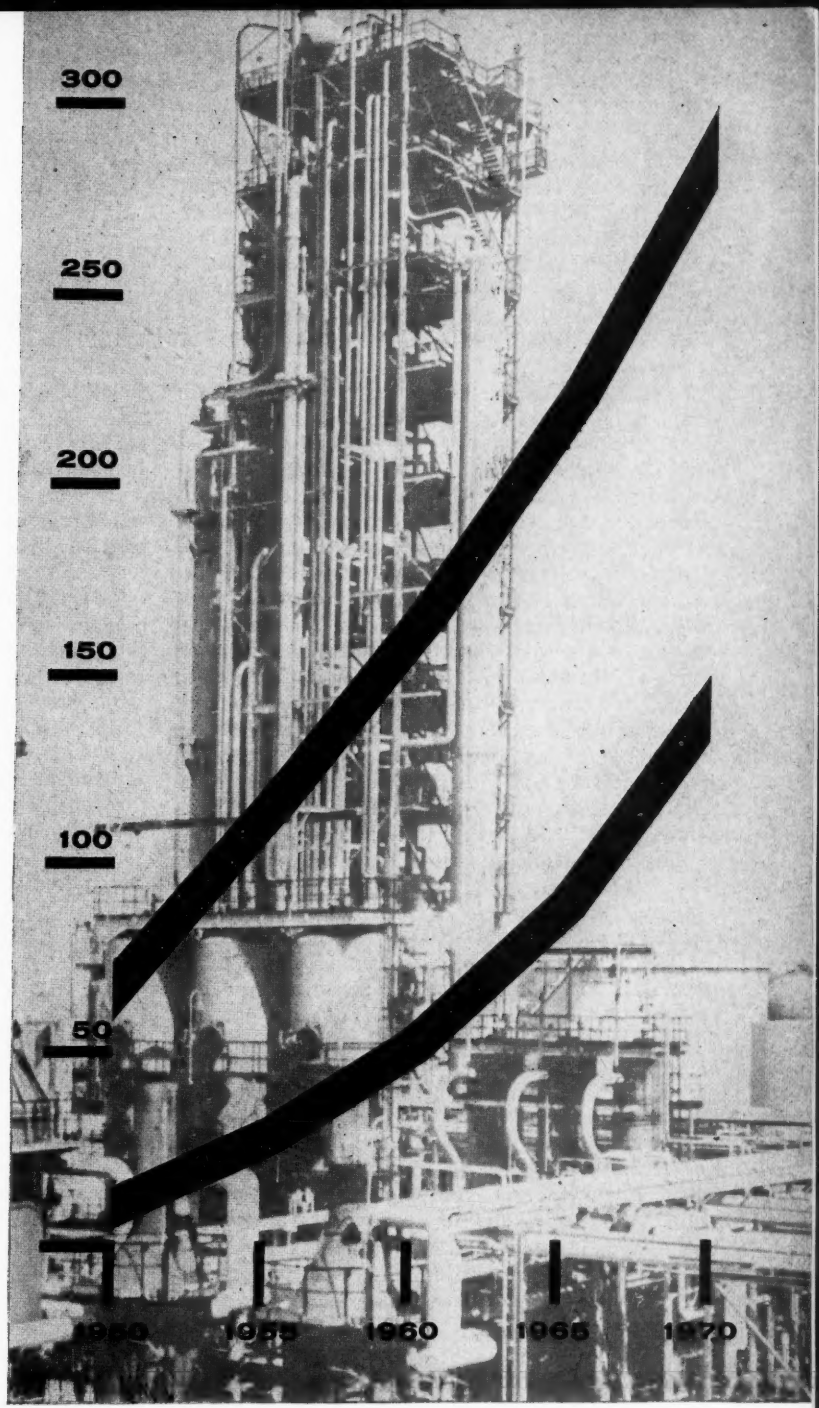
A CE REPORT

Petrochemical plants, built and planned, will be spewing out chemicals at an ever increasing rate over the next decade.

By 1970, in fact, half of all chemicals produced—150 billion pounds per year—will probably be of petrochemical origin.

What's behind this explosive growth with its consequent industry overcapacity? What's in store for oil companies, and others, attempting to move into the chemical field?



In the next decade, petrochemicals (lower curve) will nearly triple to reach 150 billion lb./year—nearly half of the total U. S. chemical capacity (upper curve).

Petrochemicals: What's Ahead

By ROLAND A. LABINE
Assistant Editor

Take an industry that has enjoyed handsome profits in the past and add market projections showing that demand for its products will be growing at 7-10% per year. Add plentiful raw materials and a processing technology readily available to all. Season with some peppery comments about how new plant capacity is going to spoil profits for everyone. The resulting stew is a fairly accurate representation of the petrochemical industry today.*

The petrochemical industry is beset with paradoxes. Although it is the fastest-growing segment of the chemical industry, there is overcapacity in almost every chemical, with downward pressure on prices. And most informed observers believe that the present construction boom will continue for the foreseeable future, causing an even greater squeeze on profits.

The main problem of the '60's is not one of production, but rather selling the chemicals once they are made. This is in marked contrast to the relatively fat years of the '50's, when the emphasis was more on producing chemicals fast enough to keep up with orders.

Some of this overcapacity can be attributed to the growing role that petroleum companies are playing in the chemical business. Oil firms traditionally overdesign their plants, pursuing profits via the "incremental barrel" philosophy (i.e., production costs on the last few barrels of throughput are lowest, hence profit is greatest).

Oil and gas companies, traditionally suppliers of basic raw materials to chemical firms, are now showing greater and greater interest in becoming firmly established in intermediates, and sometimes finished, products. At the same time, several of the big chemical companies have acquired large stakes in oil refining and gas production, giving them practically total integration from wellhead to department store in some products.

This mingling of the oil and chemical business has led some to predict that the character of the chemical industry will undergo vast change in the next ten years. Purely economic pressures are certainly tending to force integration from hydrocarbon feedstocks through consumer marketing. However, there is one big impediment to such amalgamation: the U. S. Dept. of Justice.

The department is already looking into oil company penetration of the chemical field and calls this "an area of concern." Joint ventures, one of the most popular ways for expanding in the petrochemical business, have already drawn governmental criticism.

Justice Dept. recently filed a complaint against Olin Mathieson and Pennsalt Chemicals for their joint sodium chlorate project, the first action ever taken against a joint venture. At this time, the department took pains to point out that it felt more and more companies were using the joint venture tactic to dodge the usual restrictions of the Sherman and Clayton Acts.

R. K. Dix
Enjay Chemical Co.
Chemicals offer the biggest growth potential for oil companies.

The following sections will examine some of the dominant trends in the industry today. Among these are: changing raw material economics, pressure towards regionalization, new technology, and the attraction that petrochemicals hold for oil and gas companies.

Why are there so many new entries in the petrochemical business? Many of the established firms in this field insist that the big capacity buildup will mean sharply reduced profits for everyone and especially the newcomers.

But oil and gas companies can cite some solid reasons for entering this field. First, their return on investment has been around 8 to 10%, while chemical firms, especially in the 1955-57 period, enjoyed 10 to 15% returns after taxes. As an additional inducement for natural gas firms, petrochemicals offer an opportunity to diversify in a field that is not regulated by the Federal Power Commission.

An oil company like Cosden Petroleum converts less than 4% of each barrel of crude into chemicals, yet 18% of its net profits are derived from its chemical operations.

Enjay Chemical's R. K. Dix points out that projections for hydrocarbon consumption in strictly fuel applications have a steady, but uninspiring, 2½% per year growth pattern predicted for the next decade. And competition for these well-defined markets has been steadily increasing with the present world surplus of petroleum. So, besides the hope for a greater return on investment than the fuel market offers, petrochemicals have the additional advantage of faster growth.

And a not-inconsiderable factor in the over-all economics of integrated oil companies is the depletion allowance. This furnishes a tax deduction of up to 27½% on the income from each barrel of crude produced. Assuming $3 a barrel for crude, this amounts to around 83¢ of tax-free income for each barrel charged to a refinery. It's a truism in the oil business that most of the money made by oil companies comes from production of crude rather than the refining and marketing of gasoline.

The depletion allowance is intended primarily to finance the discovery of new oil fields. But there is too much oil being produced today, and the industry has consequently reduced its exploration and drilling efforts. This has left most petroleum companies in a very favorable cash position, with chemicals seeming to be the only profitable outlet for investment.

This tax allowance could also become a factor in the pricing of petrochemical products. An integrated

* Petrochemicals are defined here as any chemical products having primary origin in oil or natural gas.

A listing of the McGraw-Hill staffers who contributed information for this report will be found on p. 130 under "Acknowledgements."

oil company has already derived a certain amount of income from its chemical raw material—crude oil—before the profit from the sale of petrochemicals is added on. This puts an oil company on a different economic footing from a chemical company that has to start with a purchased hydrocarbon feedstock.

Another factor contributing to the oil companies' cash buildup is the decreasing attractiveness of foreign investments in refineries. Return on these investments has dropped below 13%, making them less attractive, because of greater risk, than a similar U. S. investment at 9%. Concurrent with the slowdown in refinery building overseas, however, has been a stepped-up investment in foreign petrochemical plants. But the net result of these opposite factors seems to be a returning of some oil capital to the U. S. Thus, much of the cash that was formerly going abroad is now seeking outlets here.

Table I, a listing of major petrochemical projects announced within recent months, shows the increasing stake that oil and gas companies have in the chemical field. An estimated $330 million is being invested by the oil and gas industry in 1961 for new chemical plants, a 77% increase over 1960.

It is appropriate to examine the petrochemical industry's economic background, against which all of the new activity is taking place.

Poverty Amidst Plenty?

During 1960, around 56 billion lb. of petrochemicals were produced, generating $7 billion in sales. This accounts for about 30% of the chemical industry's volume output and around 60% of its sales income. The McGraw-Hill Dept. of Economics predicts that within the next 15 years petrochemicals may account for 50% of the total chemical industry volume and may account for 70% of its total income.[1] By 1970, according to Dow Chemical's A. P. Beutel, this growth will propel the chemical industry into a tie with the food business for first place among U. S. industries.

The two major growth areas for petrochemicals are polymers and agricultural chemicals. The general category of polymers, arranged in approximate order of growth potential, can be broken down into five major subgroups: (1) films, (2) plastics and resins for molding and extrusion, (3) elastomers, (4) fibers, (5) surface coatings.

Plastics and resins seem to be fascinating many of the newer entries in the petrochemical field. One of the principal reasons is that they see a tremendous potential market in the virtually untapped field of building materials.

Estimates vary widely as to the size of this potential. Plastics currently make up only 1-2% of the total

The oil companies move into petrochemicals — Table I

Who	Where	What	How Much
Amoco Chemicals	Joliet, Ill.	**Trimellitic anhydride**	Multimillion lb.
AviSun Corp.	New Castle, Del.	**Polypropylene**	100 million lb./yr.
California Chemical	Richmond, Calif	**Polybutenes**	Expanding to 50 million lb./yr.
Cosden Petroleum	Big Spring, Tex.	**Styrene**	Expanding to 60 million lb./yr.
Crown Central Petroleum	Pasadena, Tex.	**Benzene**	17 million gal./yr.
Goodrich-Gulf	Beaumont, Tex.	**Polybutadiene**	20,000 tons/yr.
		Polyisoprene	20,000 tons/yr.
	Institute, W. Va.	**Polybutadiene**	25,000 tons/yr.
DX Sunray Oil	Tulsa, Okla.	**Benzene**	1,000 bbl./day.
Gulf Oil	Philadelphia	**Cumene**	100 million lb./yr.
		Benzene	12 million gal./yr.
Humble Oil and Refining	Baton Rouge, La.	**Oxo alcohols**	Expanding to 120 million lb./yr.
	Baytown, Tex.	**Benzene**	Expanding to 55 million gal./yr.
		Polyolefins	Expanding to 80 million lb./yr.
		Para-xylene	Expanding to 105 million lb./yr.
	Bayway, N. J.	**Ethylene**	Expanding to 175 million lb./yr.
Oxo Chemicals	Haverhill, Ohio	**Oxo alcohols**	36 million lb./yr.
Phillips Petroleum	Borger, Tex.	**Polybutadiene**	25,000 tons/yr.
	Sweeny, Tex.	**Benzene**	22 million gal./yr.
Shell Oil	Marietta, Ohio	**Polyisoprene**	35,000 tons/yr.
	Torrance, Calif	**Polyisoprene**	18,000 tons/yr.
		Polybutadiene	18,000 tons/yr.
	Woodbury, N. J.	**Polypropylene**	80 million lb. yr.
Sinclair-Koppers	Houston, Tex.	**Styrene**	70 million lb./yr.
Sun Oil	Toledo, Ohio	**Naphthalene**	100 million lb./yr.
SunOlin Chemical	Claymont, Del.	**Ethylene**	225 million lb./yr.
Sunray Mid-Continent Oil	Corpus Christi, Tex.	**Styrene monomer**	60 million lb./yr.
Suntide Refining	Corpus Christi, Tex.	**Ethyl benzene**	30 million lb. yr.
		Para-xylene	15 million lb./yr.
Tidewater Oil—Collier Carbon & Chemical	Delaware City, Del.	**Naphthalene**	100 million lb./yr.

Dewey Mark
Tenneco Oil Co.
Foreign markets offer wealth of opportunity for U.S. firms.

building-material market, but this small percentage accounts for 1.1 billion lb. of resin. Extrapolation of this small share, results in a market for 2.5 billion lb. of plastics by 1970.

But if plastics can expand their share of the housing market to 25-30%, as Allied Chemical predicts, the demand for resin would jump to a dizzying 25-30 billion lb./yr. by 1970.

Of course, many formidable obstacles remain before this potential can be realized (two of the main ones being archaic building codes and the general inertia of the building industry). Koppers Co., for example, has had an active program going for the past two years to promote use of foamed styrene building panels, but it has achieved only limited success.

As an example of the progress that has been made, however, some local building codes have been modified to allow plastic pipe for cold water service.

One of the companies in the polypropylene field, Sun Oil (in partnership with American Viscose), considers home building a lucrative market goal. Recognizing that this is of necessity a long-range project, Sun sees merit in purchasing a small building-materials supply firm. In this way, it would have a ready-made outlet for experimentation with new modular panels, since much market work remains to be done before designs are evolved for mass markets.

Another area that excites the imagination of marketing men is packaging. One market observer notes that besides the mere extrapolation of existing packaging applications, there is one huge market that has not been tapped yet: packaging of motor oil. As much as 100 million lb./yr. of plastics could be gobbled up by such a market.

These same figures have also attracted the aluminum companies, which are now making strenuous efforts to penetrate the oil-can market. But petroleum companies have a much greater interest in the plastics business than in aluminum, this marketer notes.

What Threat From Foreign Competition?

Foreign competition does not seem to worry most industry men. U.S. companies are investing heavily in overseas petrochemical projects and will be a bigger factor in overseas markets than foreign firms will be here. Among the major U.S. companies that are contributing to the $1-billion petrochemical plant buildup in Europe are the U.S.'s Mobil Oil, Union Carbide, Standard Oil Co. of N. J., and Du Pont.

The petrochemical industry stands to gain much by expanding its horizons to cover the world market, declares Tenneco Oil's Dewey Mark. "In the past, U.S. companies have let the ocean barrier deter them from intensive marketing overseas." But current freight rates of about 4¢/gal. from the Gulf Coast to Chicago by barge are almost the same as ocean rates to Europe, Mark points out.

Probably a greater factor in the domestic market than the importation of foreign chemicals will be the continuing investment in U.S. plants by overseas companies. Recent examples of this are Montecatini's polypropylene plant at Neal, W. Va., and the facility built by Dow Chemical and Badische Anilin- & Soda Fabrik at Freeport, Tex.

Conversely, Standard Oil of New Jersey is spending about $100 million on overseas chemical projects this year and next.

The Problem: Making a Profit

Although the industry has substantial growth ahead of it for the next decade, the problem is that many companies see this growth and want to capitalize on it.

Chemical companies that are old hands in organics are thus facing an era of unprecedented competition. Just about everyone interviewed by *CE* for this report conceded that the rate of return on chemical investments is going to be lower than was enjoyed during the '50's, probably leveling out at around 10%.

How are chemical companies reacting to this stepped-up competition? There seems to be two main approaches. The first is a vertical integration back toward the source of the hydrocarbon raw materials, in an effort to shave production costs to the absolute minimum. Prime examples of this type of thinking were Monsanto's acquisition of Lion Oil and Dow's purchase of Bay City Refining. The second approach to competition, which seems to be more universal, is a greater consumer orientation.

The vertical integration route is a source of considerable debate among chemical industry spokesmen. On one hand, it is argued that this approach offers a greater degree of control over sources of raw material and eliminates the middle man's profit. On the other hand, the executive vice president of a large chemical firm argues that the proper role of a chemical company is the tailoring of hydrocarbon building blocks to suit specific consumer needs without investing heavily in time and money in the production of basic raw materials. "With the present surplus of petroleum," he says, "we can now make a satisfactory contract for any raw material we need. This could change in the future, of course, and with existing technology a chemical firm always has the opportunity to integrate as far back as is required."

One of the factors driving oil firms into the chemical business in the first place, is the wider availability of raw materials. Hydrocarbons are plentiful enough so that a chemical company shopping around for a feedstock can dicker over price with several competing suppliers, to a point where the price gets so low that some of the suppliers feel they might as well upgrade the raw material themselves and obtain the profit that would otherwise go to the customer.

R. L. Bateman
Union Carbide Chemicals Co.
Emphasis is shifting towards increased consumer service.

Despite these arguments, however, many chemical companies are looking for greater control of their hydrocarbon sources. Union Carbide, for example, is making all of its own building blocks in Texas through feedstock purchase contracts with several large natural-gas liquids plants.

Carbide is taking a large percentage of the liquid from Humble's huge King Ranch gas plant for Carbide's Texas City and Seadrift plants. And the firm is extending its LPG pipeline to reach from Brownsville to Baytown, enabling it to pick up feedstocks all along the Gulf Coast. Carbide will eventually have about 1,000 miles of feedstock line, most extensive of any chemical company.

Snuggling Up to the Consumer

There is general agreement on the need for greater consumer orientation on the part of the petrochemical producers. This is the area where the old-line chemical companies feel they have the edge over the newcomers in petrochemicals.

The chemical firms contend that in today's market it's no trick to make a quality chemical; the trick is to sell it. This is why these companies are spending increasing amounts of money and manpower in the areas of market development and technical service. These items, which are generally included in a company's research budget, are the main factors accounting for the ever-increasing cash outlays for research and development. McGraw-Hill's Dept. of Economics estimates that the CPI will be spending $920 million on research and development in 1964, compared with $741.2 million in 1960.

R. L. Bateman, manager of market services for Union Carbide Chemicals, lays great emphasis on this customer service aspect of the business. He points out that Carbide has just invested several million dollars in a new customer service lab at Tarrytown, N. Y., and that this portion of the business is going to be getting more and more attention from the Carbide organization.

Bateman points out, also, that the changed selling conditions in petrochemicals must of necessity bring about changes in the type of market research that is being done. "Companies must examine markets in terms of satisfaction of a use requirement, rather than forcing a particular product into an end use," he declares.

In an era when chemicals are competing more and more with each other rather than with nonchemical materials, market research must take into account the other products that could penetrate a given end-use area between the time a company completes its research and the time the plant is built. "Customers are buying functionality," Bateman notes, "not merely a chemical." Failure to observe this phenomenon, he says, has been the cause of much of the overcapacity that the industry now faces.

Another facet of this same phenomenon is a desire of most companies to get closer to the ultimate consumer. A good example of this is Enjay Chemical's move into polypropylene resin. One attraction of integration forward, toward finished products, is the ability to exercise greater control over distribution of intermediate chemicals.

Also, profit margins tend to be bigger, the closer a company is to a finished product.

Classic example of this is Union Carbide's production of flashlight batteries and antifreeze—both of which have been high-profit lines. (Of course, there are many pitfalls in consumer marketing for the unwary and inexperienced.)

Whence the Raw Materials?

More oil companies are thinking of their refineries as plants that handle several dozen chemicals—any one of which is available for other than fuel uses if the economics are right. Thus, wherever there is an oil refinery, there is the nucleus for a potential petrochemical complex.

The growing number of natural gas processing plants will have an important effect on raw-material economics. There are currently 45 new plants under way that will process 8.33 billion cu.ft./day of natural gas, raising total processing capacity to almost 41 billion cu.ft./day. Most of the methane will be used as fuel. However, about 32% of the liquids and gases separated from the methane will wind up in chemicals.

The rapid growth of LPG pipelines will mean more petrochemical potential in the Southeast and Midwest. Texas Eastern, for example, is now trying to sign up chemical customers in the Cleveland area for the LPG pipeline extension that it is planning.

According to Phillips Petroleum, sale of LPG to the chemical industry in 1960 was 3.0 billion gal., a 20% jump over 1959. Over-all increase in LPG sales was only 10.5%, with total sales amounting to 9.86 billion gal. One-third of the LPG for chemical uses went into ethylene, polyethylene, ethylene oxide and ethyl alcohol.

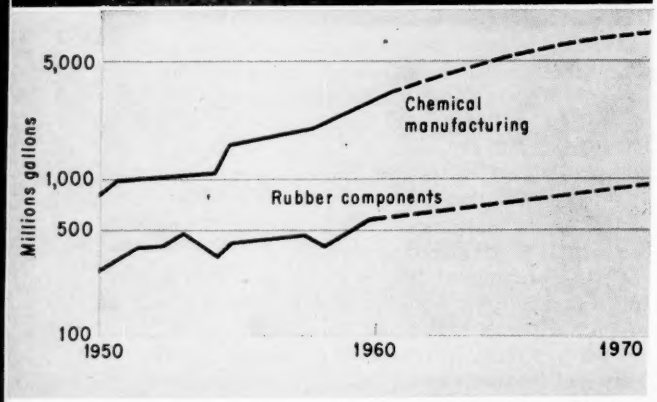
Cities Service's Howard Malakoff predicts that consumption of LPG for chemical synthesis will rise to about 5 billion gal./yr. by 1965 (see Fig. 2). He sees demand tapering off in the 1965-70 period to about 7%/yr. rate of increase for chemical uses, due to an anticipated slowing in the growth rate of the whole petrochemical industry (see Table II).

Taking Finer Slices

Modern natural gas processing plants do much more than recover LPG; some of the newest facilities separate the heavier hydrocarbons into relatively pure fractions from ethane through octane.[3]

New plants now recover 75-90% of the available

Liquid propane usage — Fig. 2



propane, with many older ones now adding additional refrigeration capacity to bring recoveries in line with this figure. Ethane is the most elusive of the heavier hydrocarbons, present recoveries being only 20% in most plants that make any attempt to recover it. Some recent installations have increased recovery to 50%, however, and other projects now under consideration will raise the level to 60%.

Ethane production during 1961 is expected to be around 23.2 million cu.ft./day, with almost all going to ethylene manufacture; production of ethane will probably double in 1962. It is currently selling for 40-70¢/1,000 cu.ft.; this large spread is accounted for by the fact that streams may vary from 25 to 90% ethane. Present trend is to higher ethane purities, with an average split at 40:60::ethane:propane.

The King of Petrochemicals: Ethylene

Ethylene is the undisputed monarch of the petrochemical kingdom, the backbone of any petrochemical complex.

On the Gulf Coast, for example, the ethylene pipeline system is the main thread tieing that vast complex of chemical plants together (see map on p. 119). Over 2 billion lb./yr. of ethylene flows through the lines; this amounts to 4,000 lb./min., or a value of $200/min. at the going price of around 5¢/lb. (see Table III for the current estimate of Gulf Coast ethylene capacity).

Ethylene is the first chemical that is considered when companies try to set up an organic chemicals complex. With its 225-million-lb./yr., ethylene plant, SunOlin hopes to get such a plant group started in the Delaware Valley. And Amoco Chemicals in the Midwest is actively seeking customers for a proposed 200 to 300-million-lb./yr. ethylene plant that it hopes to build at Joliet or Aurora, Ill.

Current annual U. S. ethylene capacity is estimated at a little over 6 billion lb., and is expected to rise to around 8.5 billion lb. by 1962. The Gulf Coast accounted for 3.5 billion lb. in 1959, will have about 5.5 billion lb. capacity by 1962. M. W. Kellogg Co. estimates that annual U. S. capacity will rise to around 10 billion lb. by 1970.

Ethylene production has grown at the rate of about 400 million lb./yr. in the past decade. And although the above figures indicate a healthy future growth, Kellogg predicts that other light olefins such as propylene, butylene and butadiene will have an even higher growth rate in this decade.

A large part of the ethylene now comes from recovered refinery gas. However, much of this "easy" ethylene has already been tapped, so companies are turning to various cracking processes to supply the demand.

As noted in the section above on raw materials, natural gas processors are extracting more and more of the hydrocarbons from wet gas streams so that the gas

Primary petrochemical usage — Table II

	1960	1965	1970
	Million Lb.		
Ethylene	5,500	7,500	9,500
Propylene	2,500	3,500	4,500
Butadiene	1,900	2,200	2,500
Isoprene	0	150	300
	Million Gal.		
Benzene	250	425	600
Toluene	150	250	350
Xylene	200	400	600

Source: Cities Services

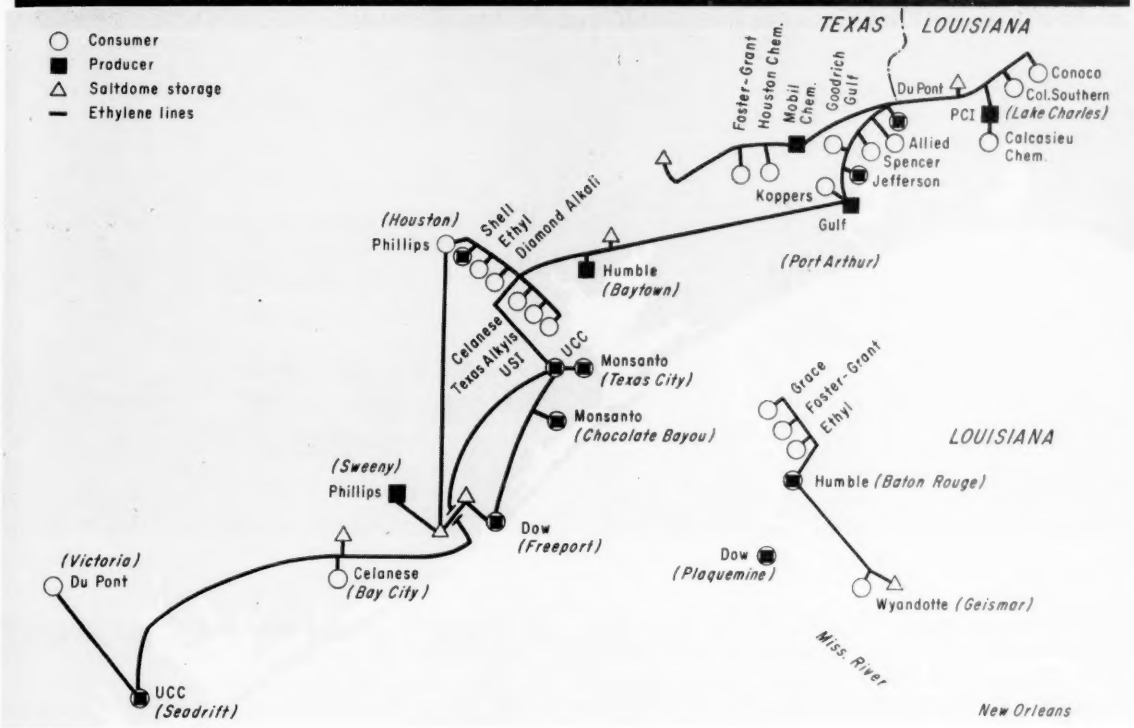
Year-end Gulf Coast ethylene capacity — Table III

(Million Lb./Yr.)

Dow Chemical	
Plaquemine, La.	105
Freeport, Tex.	500
Du Pont	
Orange, Tex.	70
El Paso Natural Gas Rexall	
Odessa, Tex.	75*
Gulf Oil	
Port Arthur, Tex.	625
Humble Oil & Refining	
Baytown, Tex.	110
Baton Rouge, La.	530
Jefferson Chemical	
Port Neches, Tex.	250
Mobil Chemical	
Beaumont, Tex.	380
Monsanto Chemical	
Texas City and Chocolate Bayou, Tex.	600
Odessa Styrene	
Odessa, Tex.	15
Petroleum Chemicals, Inc.	
Lake Charles, La.	300
Phillips Petroleum	
Sweeny, Tex.	500
Shell Chemical	
Deer Park, Tex.	150
Texas Eastman	
Longview, Tex.	225
Union Carbide Chemicals	
Texas City and Seadrift, Tex.	860

* Ultimately 200

Ethylene pipelines are the backbone of the Gulf Coast chemical complex — Fig. 3



that is put into the pipeline is predominantly methane with just enough heavier hydrocarbons put back in to meet Btu. specifications. The one remaining gas fraction that passes unrecovered through most processing plants is ethane. But ethane is an ideal feedstock for ethylene production, especially when there is no market for byproducts.

Many older processing plants are adding refrigeration capacity so that the colder absorber oil will strip out more ethane. And most new plant design pays particular attention to this fraction. Fluor Corp., for example, is completing a 900-million-cu. ft./day plant for Northern Gas Transmission Co. at Bushton, Kan. This facility employs a special Fluor-designed low-temperature process that recovers ethane along with the other heavier hydrocarbons.

Flowsheet for the plant is similar to the Fluor-designed plant of Union-Goliad at Cow Island, La., with a de-ethanizer added between the demethanizer and dehexanizer columns.[5]

Process operates at −40 F., which is about the limit for use of aluminum-killed steels. According to Fluor's W. M. Hathaway and R. W. Bucklin, utility consumption of the route is as little as 0.7% of the inlet gas. Consumption of ethylene glycol (injected in the wet inlet gas to inhibit hydrate formation) is as low as 10-30 gal./day when processing 500-800 million cu. ft./day of gas.

The −40 F. design makes it possible to process economically a lean pipeline gas (0.4-0.8 gal./1,000 cu. ft. of propane and liquid). Optimum propane recovery in the refrigerated-oil plant is 85-95%; practical ethane recovery varies from 15 to 35%.

Molecular weight of the absorption oil should be about 100 at the −40 F. level. This helps reduce plant pumping costs—an important factor since in large high-level propane recovery units, the fuel cost is greater than all other operating costs combined. Only 16.5 gal./mole must be pumped at a molecular weight of 100, while at a weight of 220 (oil used in ambient-condition plants), flow rate is about 30 gal./mol.

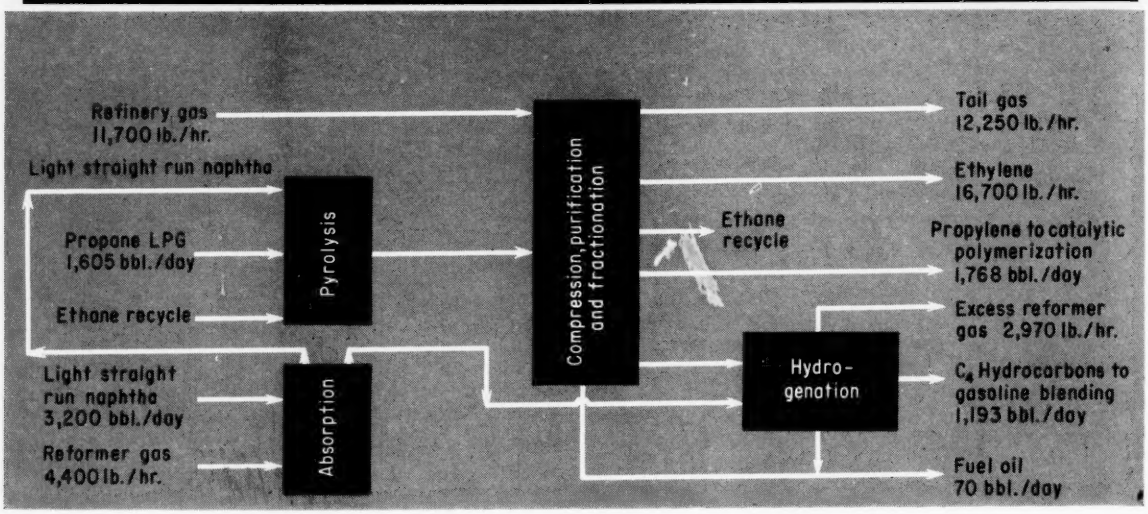
Use of 100-molecular-weight oil is also advantageous because it boils in the same range as the natural gasoline product. Thus it is not necessary to purchase lean oil for the plant after startup requirements are satisfied.

Ethylene From Refineries via Cracking

While some producers, such as Dow Chemical, at Plaquemine, La., are going to ethane as a source of ethylene, others are finding liquid feedstocks, such as naphthas, the most economical source. The huge ethylene plant Monsanto is building at Chocolate Bayou will probably use naphtha for at least part of its feed.

With naphtha feedstock, the byproducts form an integral part of the production economics. J. Chrones and A. R. Johnson of M. W. Kellogg Co. recently gave a paper at a Western Petroleum Refiners Assn. meet-

One way to produce ethylene in an oil refinery — Fig. 4



ing in Wichita, examining the economics of ethylene production from naphtha.[7] In particular, they looked at how an ethylene facility could be integrated into a midcontinent refinery. They concluded that the by-product values can reduce or even reverse the current feedstock cost advantage that the Gulf Coast enjoys.

According to Chrones and Johnson, the existing refinery with its established market can dispose of or consume the ethylene byproducts without requiring new petrochemical markets or seriously dislocating existing refinery balances. This permits future utilization of these byproducts as chemical intermediates when markets develop. Their conclusions are particularly interesting since active efforts are being made in several parts of the country to establish regional petrochemical complexes where refining capacity exists to supply such ethylene plants.

The refinery in Chrones and Johnson's example was a 50,000-bbl./day installation, typical of many existing refinery schemes. The limitations imposed on this 13.2-million-lb./yr. ethylene production unit are: (1) no refinery product will be produced in excess of the rate existing before the ethylene plant was built; (2) pyrolysis will be limited to feedstocks having other commercial uses. (This makes the plan conservative.)

A block flow-diagram for the proposed ethylene unit is shown in Fig. 4. The feedstocks are refinery gases, propane and LPG, and light straight-run naphtha. Ethane recovered from refinery gas, together with any produced during pyrolysis, is recycled and cracked to extinction. The C_3 product from both the refinery and ethylene unit is sent to the polymerization plant where it is converted to polymer gasoline.

Propane, which passes through the polymerization unit, is returned to the ethylene unit and cracked to extinction. Catalytic reformer off-gas is scrubbed with straight-run naphtha for hydrocarbon recovery prior to use as a source of hydrogen in the gasoline hydrogenation unit. Only a small amount of the hydrogen is consumed, leaving the remainder available for other treating units. Effluents from the cracking unit are combined with the refinery gas for purification, acetylenes removal, and drying.

Natural gasoline can be purchased to restore gasoline production to its original level. Table IV is a summary of ethylene manufacturing costs with and without additional gasoline purchase, comparing the Midwest production with a Gulf Coast operation. As is seen from the table, the estimated manufacturing cost of 2.79¢/lb. (with natural gasoline purchase) makes ethylene production very attractive for the Midwest. The question remaining is whether or not ethylene-consuming operations will materialize in sufficient size to support such a plant.

The New Technology

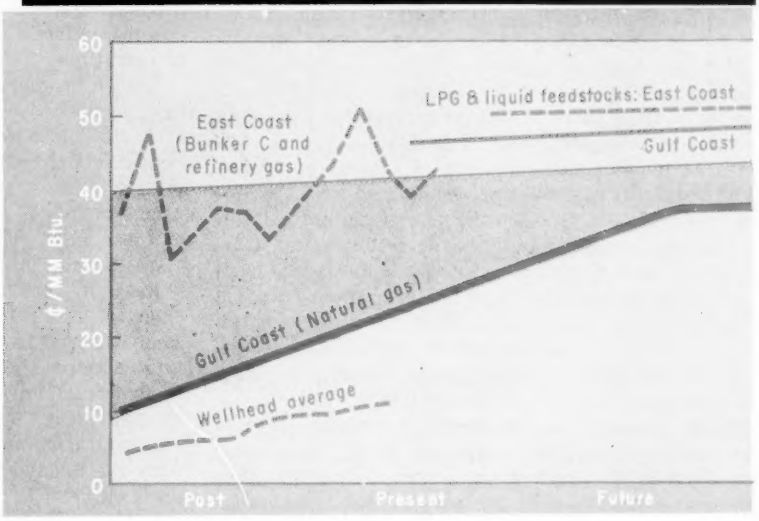
Although much is said about "fast-paced technology," few plants in the petrochemical industry are based on what can truthfully be called new developments. It is getting increasingly difficult to find proc-

Ethylene manufacturing costs — Table IV

	No Natural Gasoline Purchase		With Natural Gasoline Purchase	
	Midwest ¢/Lb.	Gulf Coast ¢/Lb.	Midwest ¢/Lb.	Gulf Coast ¢/Lb.
Net feed cost	2.04	1.87	1.18	1.45
Direct oper. cost	0.34	0.31	0.34	0.31
Indirect cost*	1.27	1.27	1.27	1.27
Total mfg. cost ¢/lb.	3.65	3.45	2.79	3.03

* Based on: Maint. @ 4% of Investment. Tax & Ins. @ 2% of Investment. Int. @ 3% of Investment. Deprec. @ 10% of Investment. Overhead @ 80% of Labor + Supervision.

Regional cost gap narrows — Fig. 5



T. E. O'Hare
M. W. Kellogg Co.
Direct synthesis offers the best hope for cutting costs.

esses and products that are both new and economical.

The bulk of today's petrochemical projects rely upon engineering refinements of existing processes. Much of the polyolefin industry, for example, is based upon the basic Ziegler-Natta discoveries of the early '50's. The extraction processes for natural gas liquids outlined above are by and large refinements of earlier techniques, perhaps incorporating a new or modified solvent. Olefin, acetylene and hydrogen production processes that are being used in new plants are outgrowths of the developments of a decade ago.

One promising new approach is the concept of direct synthesis. According to T. E. O'Hare, M. W. Kellogg economist, "the need for new technology becomes acute when engineering improvements to an existing process contribute only a marginal decrease in operating cost. This is especially true with processes whose operating cost is more than 50-60% feed material charges. At this point, the perfection of a more-direct synthesis is certain to bring about a significant manufacturing cost reduction."

A "more-direct synthesis" can be thought of as the manufacture of a petrochemical through the use of a single or two-step process rather than the multi-step process sequence now employed. The direct synthesis of acrylonitrile from propylene and ammonia is a good example. And so is the direct synthesis of acetaldehyde from ethylene via the Wacker process.

The multi-step process sequence was unavoidable in the older organic chemistry. Today, however, it can often be eliminated by skillful management of pressure, temperature and catalysis. O'Hare points out that "any reduction in the number of chemical reactions through which the raw material must pass will decrease investment and operating costs and will usually improve yield. This drive toward direct synthesis is the most promising avenue of Kellogg's current chemical research work." It is O'Hare's opinion that herein lies a remedy for the profit squeeze threatening the industry.

Licensing

One of the significant aspects in petrochemical technology is the increasing availability of processes for licensing. This was amply illustrated in *CE's* petrochemical report in 1959, which listed over 500 processes that were available from U. S. and some overseas companies.[6] As has been stated before, this widespread availability of processes for making practically any organic chemical is responsible to a large degree for the explosive capacity growth.

The large engineering and construction firms that have been process designers and builders for the oil and gas industry are keenly aware of the new emphasis on chemical aspects of the petroleum business, as a consequence of slackening in refinery construction. The petroleum industry has a long history of cross-licensing, so it is natural for this practice to spread over into the chemical end of the business. Thus the engineering companies are gearing to participate in the chemical industry by attempting to assemble as wide a range of processes as can be obtained.

F. M. Pyzel, director of process development for the Foster Wheeler Corp., says that with respect to licensing the petrochemical industry is at the same

point the oil industry was prior to World War II. At that time, the oil companies initiated a relatively free exchange of process knowledge.

The heavy chemical industry, Pyzel predicts, may be gradually changing its policy of process secrecy.

One outstanding example of the overlapping of chemical and petroleum technology is the Ashland-Universal Oil Products' Hydeal process for producing benzene and naphthalene. This process was an offshoot of hydrocracking research aimed at upgrading light distillates into gasoline. But faced with the aromatic shortage of 1959-60, the process proved suitable for giving petroleum refiners the technological shoehorn they needed to squeeze into the naphthalene business. And as was typical of the oil company way of thinking, Ashland not only utilized the process in two of its own plants, but also made it available for licensing. At the time of this writing, Hydeal has been licensed for use in at least four plants.

There seems to be little inclination on the part of the large engineering companies to do very much process research and development on their own. They feel that competition in the construction business today is so keen that the expense of drawing up proposals, along with other overhead, precludes much original research. Some smaller firms have been fairly successful, however, in process development for specific chemical products.

The Trend Toward Regionalization

Although the Gulf Coast is now, and will continue to be, the heart of the domestic petrochemical industry, there is a perceptible movement toward creation of three other centers, to be located on the East Coast, in the Midwest, and on the West Coast.

One of the principal reasons for this is the increasing cost of natural gas on the Gulf, which diminishes its raw-material advantage (see Fig. 5). Also, the Gulf Coast is a considerable distance from the population and consumer centers of the country. When it becomes important to start counting pennies in figuring profit margin, producers naturally are going to examine transportation costs with considerable care and attention.

Then, too, with several small plants located around the country, it's less likely that disasters or strikes could choke off a company's entire output of any particular chemical.

Since these three other regions all have a large oil refining capacity that is virtually untapped for petrochemical raw materials, there is considerable activity, especially in the Delaware Valley, to build up modest (by Gulf Coast standards) petrochemical complexes.

The Small Regional Plant

As an outgrowth of the trend toward regionalization, discussed below, there is increasing interest in *smaller* chemical plants. This trend runs counter to the incremental unit cost concept, which is one of the chemical engineer's favorites: the greater the production rate, the lower the unit production costs will be.

Regional plants, however, cannot allow this philosophy to blossom fully, because the limited size of the market is the final determinant of plant size. The design engineer must operate within this given set of conditions.

A good example of this principle is Dow Chemical's new polypropylene facility at Torrance, Calif., rated at 12 million lb./yr. This unit, designed for only the Southern California market, is one-third to one-fifth the size of most polypropylene plants now being built.

One chemical engineer, experienced in the design of these small regional plants, outlined for *CE* some of the special problems.

Basically, the facility must be able to produce a chemical at a cost lower than that of shipping in the same material from another (much larger) plant. The large plant, designed for bigger markets, thus sets the upper limits on capital and operating costs for the smaller plant. The regional unit must then be designed to keep under these maximums, while working with the handicap of a smaller capacity to base unit costs on.

Designing a plant to fit within these maximum allowable figures presents unique problems. First, this type of plant cannot be designed by engineers not intimately familiar with all details of economics and process techniques, incremental advantages available at given sites (such as plant services and buildings) and general market conditions that might indicate cost-saving methods.

Second, the time and cost for engineering this type of plant is higher, on a percentage basis, than standard units because of the greater skill required and increased intensity of preliminary engineering design efforts, plus the fact that the total capital base is smaller.

Note that the exponential factor used by cost estimators does not apply to this special type of plant. Recent studies have shown that existing production units could be reduced in capacity by as much as two-thirds while maintaining linearity of capital requirements and keeping identical over-all costs of production.

The small regional plants also fit in with the increased emphasis on technical service. A local production unit can offer several advantages in customer servicing. In plastics, for example, there is often a need to work closely with the molders and converters. Having local plant people call on the customer can reduce service costs and seems to impress the customer more than sending a technical representative from the home office.

This small-plant thinking has been carried even further in some engineering organizations, which are talking about mounting small plants on railroad cars, or barges. What would make this type of plant feasible would be a large customer with widely fluctuating seasonal demands, plus a substantial transportation cost differential between the raw material and the finished product. The tax implications of such a portable plant are also intriguing because there would be no real estate taxes.

Now, we will look at the trends in the petrochemical industry in the four main producing regions in the U. S.

The Great Southwest

The Southwest will continue to be the petrochemical heartland of the U. S. The reason is very simple: the Southwest has the lion's share of this country's oil and gas reserves.

J. M. Dale of Southwest Research Institute recently presented a detailed appraisal of the Southwest's petrochemical assets.[9] According to Dale, proved reserves of crude oil in the Southwest are approximately 23.3 billion bbl., or 69% of the nation's total. Around 10-15 billion bbl. of oil may yet be found on the continental shelf off the Texas and Louisiana coasts.

Already 1.5 billion bbl. of crude oil and 10 trillion cu. ft. of natural gas have been discovered in the Gulf of Mexico. In this respect, the Louisiana offshore has been around 100 times more successful than the Texas offshore, a factor that may have a significant impact on Louisiana's future as a petrochemical center.

Proved reserves of natural gas in the Southwest are around 212 trillion cu. ft., or about 82% of the nation's total. Its share of natural-gas-liquids reserve is around 5.6 billion bbl., or 87% of the total.

In addition, the Southwest has about 40% of the nation's crude oil refining capacity.

Costs of Raw Materials

In his examination of trends in pricing, Dale sees a significant upward pressure of raw-material costs in the mid-1960's. Although crude and natural gas are in long supply now, Dale predicts an increased demand in a few years that will enable producers to get higher prices for their products, which will bring profits more in line with current costs of replacing reserves. The petrochemical industry, which uses only 1-2% of all the oil and natural gas produced in the U. S., will be in no position to set the price on these materials. Fuel demand will continue to dominate the price structure.

One big factor in this upward pressure on crude oil prices (currently, around $3/bbl.) is that the dry-hole ratio has increased from 20% in 1937, to around 40% today. Also, few large fields are now being discovered, and the wells are going deeper and deeper.

One bright spot in this otherwise discouraging picture is the prospect for offshore discovery. Although many operators are quick to point out that offshore operating costs are about nine times what they are on land, Dale notes that they have found about nine times more oil and gas per well drilled, compared with land operation.

Price increases are also in store for natural gas, says Dale. Currently averaging around 20¢/1,000 cu. ft. at the well-head, natural gas will probably be bringing more than 30¢/1,000 cu. ft. by 1970.

Refinery off-gases, which account for about 50% of petrochemical raw materials, and natural gas liquids will not increase in price as rapidly as natural gas itself. This points to an increasingly important role for these feedstocks in petrochemical production.

Dale points out that his analysis assumes that the domestic petroleum industry will be able to maintain the present degree of protection, such as import quota controls. Without such devices, Middle East and South American crude could dominate the entire market and nullify the raw material cost advantages of the Southwest.

Another possibility is that large quantities of Venezuelan natural gas might be liquefied and delivered to the U. S. The successful experiments with the liquefied methane tanker, *Methane Pioneer*, have shown that such a project is at least technically feasible.

Outlook for Plant Growth

About 80% of the nation's petrochemical capacity is concentrated in the Southwest, accounting for over $4 billion in plant investment. And most observers estimate that the present growth rate will enable the region to keep substantially the same share, although growth in other areas of the country will appear more dramatic because they are starting from a smaller capacity base. Around half the petrochemical projects now under way or planned will be located in the Southwest.

Accounting for this steady growth: raw materials (and water supply) are the prime consideration in most plant location selections. Also, petrochemical complexes tend to feed and build on themselves, and nowhere is the feast more abundant than in Texas.

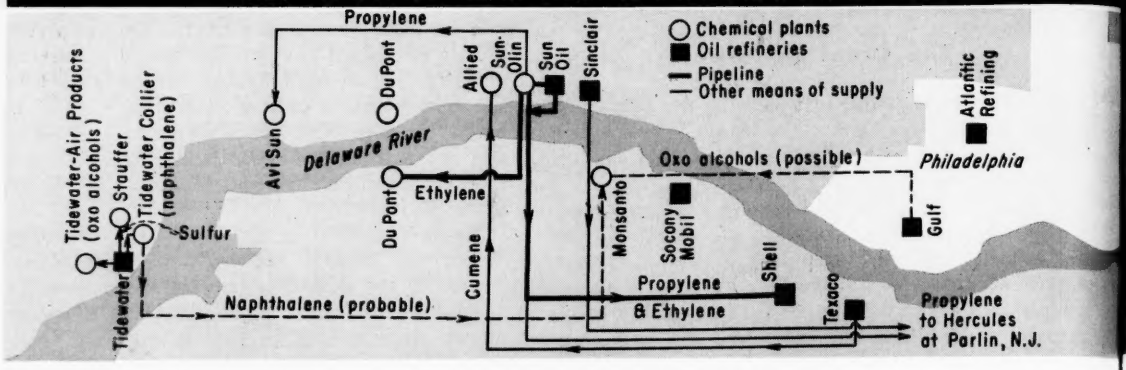
The Southwest is also endowed with over 300 salt domes, which provide the most economical method of hydrocarbon storage. Roughly 75% of all underground storage facilities are located there.

Of the major petrochemical groups, the aliphatics (ethylene-, propylene-, butylene-, and acetylene-based chemicals) will account for two-thirds of the projected chemical growth in the Southwest, says the Federal Reserve Bank of Dallas. The inorganics (ammonia, sulfur and carbon black) will make only a small contribution to the over-all growth in that locale. Although petrochemical aromatics production is now concentrated in the Southwest, capacity growth for these materials (with the exception of benzene), probably will be moderate. Demand is expected to increase relatively slowly, and because aromatics can be produced successfully on a small scale, other regions will probably account for a large share of the new plants.

Ethylene is now available on the Gulf Coast for about 20% less than on the East Coast, and this cost advantage is likely to continue as a result of the wide variety of suitable raw materials available in the Southwest. The bulk of new ethylene capacity, therefore, and most ethylene-based intermediates will remain on the Gulf.

Growth prospects for propylene-based chemicals in the Southwest are even more promising. Only a small

Integrated chemical complex shapes up in the Delaware Valley — Fig. 6



percentage of the considerable quantity of available propylene is now being tapped for chemical use, and substantial diversion of propylene from refinery uses to chemical manufacturers is forecast. Principally because of low raw-material costs (as much as 40% less than ethylene), propylene chemicals can be expected to win markets from competing materials.

The Permian Basin

One area of Texas that is receiving much attention for petrochemical expansion is the oil- and gas-rich section known as the Permian Basin. This oval about 100 miles long and 90 miles wide, with its center near Midland, Tex., contains 23% of the nation's oil and 18% of its gas. Total chemical plant investment is now over $60 million, and plants under way or planned will more than double this total.

The major petrochemical manufacturers already in the basin are Cosden Petroleum, El Paso Natural Gas, and General Tire. El Paso, in combination with Rexall Drug & Chemical Co., is providing the bulk of activity in the basin with a 200-million-lb./yr. ethylene and propylene plant, and a 120-million-lb./yr. high-pressure polyethylene plant now under construction. Raw materials for this complex will be natural gas liquids extracted from the Permian Basin wells. The companies established there are actively promoting expansion of their budding petrochemical complex.

Despite very low raw-material and fuel costs, petrochemical development in West Texas appears to be limited by comparatively high transportation costs to major markets. Compared with a Gulf Coast location, this freight disadvantage may range from ¼ to ½¢/lb. of finished product. This would make West Texas most attractive to producers who are seeking low-cost feedstocks and are willing to carry the processing to a point where the product is relatively high-priced (e.g., polyethylene) so that rail shipping costs are not a major handicap.

Because the Houston Ship Channel is firmly established as the hub of petrochemical activity in this country, it could go on growing indefinitely if it weren't for one factor: just about all the available plant sites have been snapped up. There is still considerable room for growth, however, on properties that have been purchased, but not yet developed. Monsanto is building a $100-million complex at Chocolate Bayou near the channel; Humble is mulling plans for a similar complex on its West Ranch property, across the ship channel from Baytown.[10]

Rivals to the Ship Channel

An area that may someday rival the Houston Ship Channel is the stretch of Mississippi River between Baton Rouge and New Orleans. It has a good water supply, a stabilized tax situation, and vast, still-not-fully-determined oil and gas fields off shore.

Typical of the type of operation that could develop is the Union-Goliad gas processing complex[3] that separates ethane, propane, and butane from natural gas. This plant supplies Dow with its ethylene feedstock at Plaquemine. Another grouping of plants has sprung up at Geismar, La., where Wyandotte already has an ethylene oxide plant. Monochem is building an acetylene-vinyl chloride monomer facility that will support other plants being built by Borden and Morton.

Shell Chemical already has a large chemical operation at Norco, La., and Humble is a big supplier of ethylene from its Baton Rouge refinery.

The Port Arthur-Beaumont-Lake Charles area is also in for some sizable growth, with an expanded port at Lake Charles now on the drawing board. The Toledo Bend Dam project now under way on the Sabine River will add significantly to the region's industrial water supply. Another dam, across Trinity Bay from Baytown on the Trinity River, will make more industrial water available in that area, too. This section has tremendous storage capacity in underground salt domes. Reports are that Dow at Freeport, Tex., is promoting more satellite plants, such as the recent Nalco tetraethyl lead facility, for which Dow could supply feedstocks.

The East Coast: Ready to Go

From a petrochemical standpoint, the East Coast —and especially the Delaware Valley—is at the economic take-off point.

Refinery Capacities, Bbl./Day	
Atlantic Refining Co., Philadelphia	154,000
Gulf Oil Corp., Philadelphia	192,000
Mobil Oil Co., Paulsboro, N. J.	91,600
Sinclair Refining Co., Marcus Hook, Pa.	140,000
Sun Oil Co., Marcus Hook, Pa.	160,000
Esso, Inc., Westville, N. J.	73,000
Tidewater Oil Co., Delaware City, Del.	150,000

In relation to its consumption of organic chemicals, and its potential for producing these materials, the East has been an underdeveloped area. Several oil and chemical companies have realized this, and an integrated petrochemical complex is taking shape along the banks of the Delaware River. Although this area is in for a large percentage growth, it will continue to be just a miniature edition of the petrochemical center along the Houston Ship Channel.

Several factors argue for further intensive petrochemical development in the Delaware Valley. It has 63 million people within a 300-mi. radius, which reduces distribution costs for intermediate and finished goods. For raw materials, there are seven large refineries with a combined capacity of almost 1 million bbl./day. Water supply is good, with the Delaware River alone furnishing a mean average flow of 15,700 cu. ft./sec. Almost 6,600 acres of land is still available on the New Jersey bank.

Naphthas, which are becoming an increasingly popular cracking feedstock for ethylene and propylene, are in long supply in Europe. If tariff regulations are altered, this naphtha could provide a large supply of inexpensive hydrocarbons. Gulf Oil's Jerry McAffee raised this possibility at the dedication of Gulf's oxo alcohol plant earlier this year. In addition, if there is any loosening of crude oil import quotas, the East Coast could obtain large quantities of Middle East or South American crudes at lower prices than are now being paid for domestic.

Most new petrochemical markets in the Delaware Valley will be found in plastics and resins. The majority of the nation's plastics converters are in this region, and plastics producers with local plants will have all the customer service advantages noted above.

The Delaware Valley

Sun Oil was the first oil company to really organize the petrochemical potential of the area. Sun produces 120 million lb./yr. of propylene at Marcus Hook, Pa., and through jointly owned subsidiaries AviSun (with American Viscose) and SunOlin (with Olin Mathieson), Sun is involved with the following facilities: 100-million-lb./yr. polypropylene plant at New Castle, Del.; 225-million-lb./yr. ethylene plant, 55-million-lb./yr. ethylene oxide unit, 1-million-cu. ft./day carbon monoxide plant, 12-million-cu. ft./day hydrogen plant and 73,000-ton/yr. urea facility, all at Claymont, Del. In addition, SunOlin is ready to consider methanol and formaldehyde, says president J. I. Harper.

To spur petrochemical development, SunOlin is also building a pipeline system, which will extend under the Delaware River, connecting the Delaware side with New Jersey. Among the customers that SunOlin has lined up: Du Pont at Deepwater, N. J. and Shell Chemical's polypropylene plant at Woodbury, N. J.

Gulf Oil, the second largest merchant supplier of ethylene on the Gulf Coast, has indicated that it is considering starting a similar operation in the Delaware Valley to compete with SunOlin. The one major factor holding it back right now is the lack of potential outlets. Gulf is already producing oxo alcohols at Philadelphia, and is building plants for benzene and cumene.

Monsanto Chemical is building a fluid-bed phthalic anhydride plant near Paulsboro, N. J., and will probably get at least a part of its petronaphthalene requirements from the 100-million-lb./yr. Tidewater-Collier plant at Delaware City, Del. A logical extension of Monsanto's operation might be a plasticizer plant that could combine Gulf's oxo-alcohols with phthalic anhydride.

Another big factor on the East Coast, although a considerable way from the Delaware Valley, is Humble's big refinery at Bayway, N. J. Enjay Chemical, its marketing arm, has been actively seeking olefin customers, is currently supplying General Aniline & Film, Hercules Powder, Koppers, and Nopco from its 195-million-lb./yr. ethylene unit.

Enjay had bid to supply Shell Chemical at Woodbury, N. J., but lost out because of distance. The densely populated New Jersey area is not the most ideal location for laying pipeline. Esso has been experimenting with tank-truck and tank-car shipment of liquid ethylene, however, and feels that this may provide a substitute when pipelines aren't feasible.

Probable next major move on the East Coast is vinyl chloride monomer. One company has made a study of the VCM market, and calculates that the most economical starting material would be acetylene derived from calcium carbide. Others feel, however, that the process utilizing a mixed ethylene-acetylene feedstock might prove more economical. They point out that such a charge stock could be made by naphtha crack-

J. I. Harper
SunOlin Chemical Co.
A new petrochemical complex is planned for the Delaware Valley.

ing, and the ethylene-acetylene mixture used directly without separation.

East Coast Economics

As illustrated by Fig. 5, the basic hydrocarbon costs on the East Coast are increasing at a slower rate than on the Gulf. Natural gas costs about 40¢/1,000 cu. ft. in the East, which is too expensive for fuel, so the cost of Bunker C is the base price against which other streams are valued.

The Gulf Coast cost of around 20¢/1,000 cu. ft. for natural gas (20¢/million Btu.) sets an LPG price of about 4¢ per gal. (47.7¢/million Btu.), and Bunker C at $2.30/bbl. (37¢/million Btu.). By contrast, Bunker C is currently priced around $2.60/bbl. in the Northeast, around 41¢/million Btu.

Because hydrocarbons are cheaper in the Southwest, Gulf manufacturers have an advantage of 20¢/million Btu., which creates a 1¢/lb. saving in making a building block such as ethylene. This can be translated into an advantage of as much as 1.4-1.9¢/lb. in manufacture of high- or low-pressure polyethylene, 1¢/lb. for styrene monomer and 1.2¢/lb. for ethylene glycol.

There are two main variables in this hydrocarbon equation. One is the rate at which the gap is closing between cost of hydrocarbons on the Gulf and in the East. H. K. Nieuwenhuis of Chemical Project Associates estimates that the present 20¢ differential will shrink to 6-7¢ eventually, although probably not before the end of this decade. As the differential shrinks, shipping costs become more important and provide an impetus for locating new plants close to the ultimate consumer.

Second variable, and a harder one to pin down, is the effect of hydrocarbon imports. Present import quotas prevent Eastern refiners from charging large amounts of lower-cost foreign crude to their refineries. An easing of import restrictions would have a major effect on the refinery economics, and consequently on the production of chemicals from refinery streams. Another variable, as noted above, is the present availability of light gasoline in Europe. If this material could be imported under a special license as a chemical feedstock rather than fuel product, it would be an ideal starting material for ethylene or acetylene production.

The byproduct credits for naphtha cracking (many more sideproducts are created than when ethane is cracked to ethylene) are higher in the East than on the Gulf, which makes the naphthas all the more attractive.

The Midwest: The Fuse Is Lit

Many of the same reasons that make the East Coast attractive for petrochemical development also apply to the Midwest, though to a lesser degree. There is a large consuming population concentrated in a small area, plus a large oil refining complex that could easily provide all the necessary hydrocarbon feedstocks.

A recent study made by the University of Illinois notes with some surprise that one of the few major industries not well represented in the Chicago area is petrochemicals. The study points out that synthetic rubber and polyethylene have huge markets in the Chicago area and that there are many natural gas pipelines, in addition to plentiful supplies of surface and ground water, sulfuric acid, and chlorine. There is also a large limestone-sandstone formation, which slopes down from Wisconsin to southern Illinois, that can be used for underground storage caverns.

J. Forrester
Amoco Chemicals Corp.
Customers are wanted for firm's new Chicago ethylene-propylene facility.

In the Chicago area alone, there is a 600,000-bbl./day crude oil refining capacity. And it's estimated that the refinery streams have two to two-and-one-half times the value they have on the Gulf Coast, based on alternate use as fuel. The main petrochemical operation now is Amoco Chemical's 60-million-lb./yr. xylene oxidation plant at Joliet, Ill. Amoco is also starting up a semicommercial plant to produce trimellitic anhydride from pseudo-cumene supplied from Humble's Baytown, Tex., refinery.

Union Carbide Chemicals at Whiting, Ind., has one of the pioneer petrochemical plants. It uses streams from the adjacent American Oil Refinery, to produce ethylene and propylene derivatives.

Amoco Chemicals is the moving force behind a current drive to get a more integrated petrochemical industry into the Chicago area. The company has completed a feasibility study for a 200-million-lb./yr. ethylene-propylene plant that could produce ethylene for sale at 5-5½¢/lb., competitive with the Gulf Coast. A definitive engineering study is now under way and will be completed by the end of the year.

Likely sites for Amoco's facility would be Joliet or Whiting, Ind. Joliet, where Amoco already owns considerable land, is located on the inland waterway and is served by several gas pipelines and railroads. Whiting, because it is where American Oil has its huge refinery, is another possible site, but there is less land available for potential ethylene customers to build plants.

Amoco Chemicals' president, Jay Forrester, estimates that there is an immediate market for 300 million lb./yr. of ethylene in the Chicago metropolitan area, mostly in polymers. The market for propylene is about half of that. Markets wouldn't be restricted to the Chicago area alone, notes Forrester, but would extend into much of the Midwest and Middle South via the inland waterway. "A substantial increase in the number of petrochemical consumers will follow if there is an adequate supply of building blocks," predicts Forrester.

Another possibility being evaluated by Amoco is the production of polymers. Although it is thinking mainly in terms of merchant supply of ethylene and propylene, polyolefin production would dovetail neatly

with its other operations. In terms of the Chicago market, Amoco regards polyethylene and polypropylene the most promising growth materials, with polystyrene next and polyvinyl chloride fourth.

Standard of Indiana already has its own linear polyethylene process, which it has licensed to the Japanese firm, Furakawa Chemical. It is now getting samples from the Japanese plant for evaluation and has the opportunity to collect operating data on the full-scale plant to work up economics for a possible U. S. installation.

Sinclair Oil is also believed to be trying to line up ethylene customers that could be supplied from the firm's East Chicago refinery.

Ohio: An Unknown Quantity

Several companies, notably Texas Eastern Transmission Corp. and Cleveland Electric Illuminating Co., are trying to promote petrochemical operations around Cleveland. But there is little concrete evidence of anything coming to fruition in the near future.

Petrochemical activity in Ohio is quite limited. Sun Oil at Toledo will soon be producing petronaphthalene, and Sohio is making acrylonitrile by its own propylene-ammonia process, also at Toledo. There is over 400,000 bbl./day of crude oil refining capacity in Ohio, more than enough to supply any potential chemical operations. The problem is one of finding enough markets to justify building the large plants necessary for economical production. Sohio admits it is evaluating ethylene production, but won't say what its plans are.

Some acetylene is produced around Ashtabula by the calcium carbide process. But this is evidently a marginal operation since the acetylene capacity is not being expanded. Current price of acetylene in the area is around 13¢/lb. Several of the rubber companies have indicated interest in acetylene at 10¢/lb. for use in making PVC. But the volume involved evidently is not large enough to interest any refiner in making acetylene by partial oxidation.

Texas Eastern Transmission Corp. has proposed extending an existing pipeline from its Cleveland terminus to Painesville or Ashtabula. This line would carry LPG liquids to potential chemical consumers. Among the assets that Texas Eastern is pointing out to likely customers are the area's plentiful supply of fresh water, good transportation facilities (including access to the St. Lawrence Seaway), and large salt beds that can be used for raw materials or for underground storage. Texas Eastern reports that it has generated a lot of interest in this project, but as of this writing, no known customers have been signed.

The West Coast

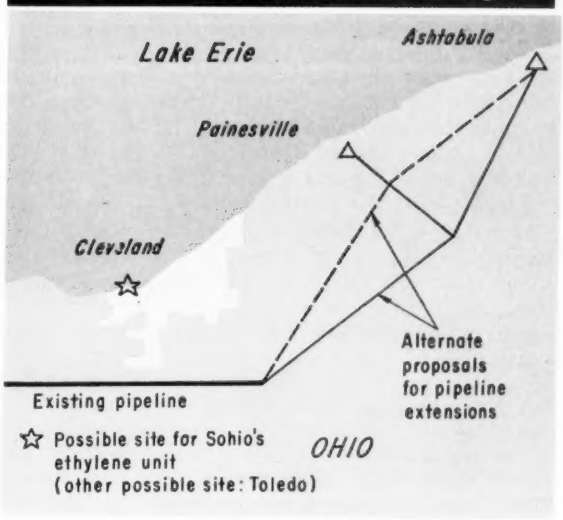
Of the four regions examined in this report, the West Coast is farthest removed from large-scale growth in petrochemicals. The reason for this is simple: the West Coast is isolated by the Rocky Mountains from the major markets in the rest of the country. Therefore, any petrochemical plant is largely limited to the West Coast market. In addition, there

New Midwest ethylene plant sites? — Fig. 7

Capacity of Major Refineries Around Chicago, Bbl./Day

American Oil Co., Whiting, Ind.	235,000
Sinclair Refining Co., East Chicago, Ind.	120,000
Mobil Oil Co., East Chicago, Ind.	36,000
Cities Service Oil Co., East Chicago, Ind.	37,800

Ethylene and LPG pipeline extensions — Fig. 8



Capacity of Major Refineries in Ohio, Bbl./Day

Standard Oil of Ohio	
Cleveland	55,000
Lima	50,000
Toledo	60,000
Sun Oil Co., Toledo	95,000

is poor water transportation and high rail rates between population centers.

There is much talk, however, about the establishment of a full-fledged industry there in the next decade because of the rapid growth in population. As of the 1960 Census, California's population was 15,700,000 and this is expected to rise to 21,100,000 by 1970. Existing petroleum refineries and natural gas pipelines can provide the basis for the establishment of petrochemical plants when the market seems right.

This West Coast population size creates a unique opportunity for the small-plant design that was discussed above. Such a unit is small enough to serve the limited market, yet economic enough to undercut the cost of shipping the chemical from other parts of the country. This is the approach that Dow Chemical has taken at its Torrance, Calif., polypropylene plant and its Kalama, Wash., phenol plant.

The alternative is to locate a big plant on the West Coast that would serve rational markets. This is difficult for anyone except well-established companies like Standard Oil of Calif. because of transportation costs.

One of the biggest problems in planning synthetic organics for the West Coast is that the area can usually support only one plant for each material. When market projections show that consumption has risen to a point where it can support an economically sized plant, more than one company may get the same idea.

Phenol provides a good example of this. Both California Chemical and Monsanto decided at the same time that the West Coast was ready for a phenol plant. So both plants were built and created a period of relative overcapacity.

The West Coast seems to be an eloquent argument for long-range planning. Companies that are interested in establishing chemical operations there are going to have to establish the need for the chemicals well in advance and act accordingly, or else they may find they aren't the only ones with the same idea.

Allied Chemical used this thinking in announcing a 15-million-lb./yr. toluene diisocyanate plant in California. Initially, some of the TDI will have to be shipped east to establish an economical rate of operation. But Allied's move will have the effect of discouraging other producers from locating on the West Coast.

San Francisco Bay Area

California comprises the dominant share of the West Coast petrochemical market. The state can be divided into two major population centers, the San Francisco Bay area and Los Angeles.

In the San Francisco area, there are four refineries located on the northern edge of Contra Costa county: Standard Oil of California, Tidewater Oil, Union Oil, and Shell Oil. Shell and Union, because of the nature of their refining operations, don't have much potential to supply petrochemical building blocks. Between Tidewater and Standard, however, there is a potential supply of almost 1 billion lb. per year of ethylene and propylene, several hundred million lb. of butylene, 100 million lb. of styrene, 8 million lb./yr. butadiene, 200 million lb./yr. of ortho- and para-xylene, and 200 million lb./yr. meta-xylene.

R. G. Luskin
American Chemical Corp.
A plastics buildup is forecast for California.

In addition, Pacific Gas & Electric Co. is now completing a 1,400-mi. pipeline to bring 4 million cu. ft./day of Canadian natural gas into the Bay area. Terminus of the line will be at Antioch, which also happens to be at the mouth of a deepwater channel that is being carved out of the Sacramento River. PG&E says that there are many chemical and petroleum companies looking at this natural gas as a petrochemical source.

The deepwater channel is a big factor in petrochemical planning in the Bay area. It starts at Antioch and will eventually extend all the way up to the state capital at Sacramento. This extension of the channel will open up one of the fastest growing population centers in the U. S. Most of the land along the channel is still used for agriculture, but it is expected that much of it will soon be optioned for industrial use. Tidewater, for example, has 500 acres allotted specifically to petrochemical development. Rohm & Haas also has an option on a large piece of land along the channel.

The Possibilities

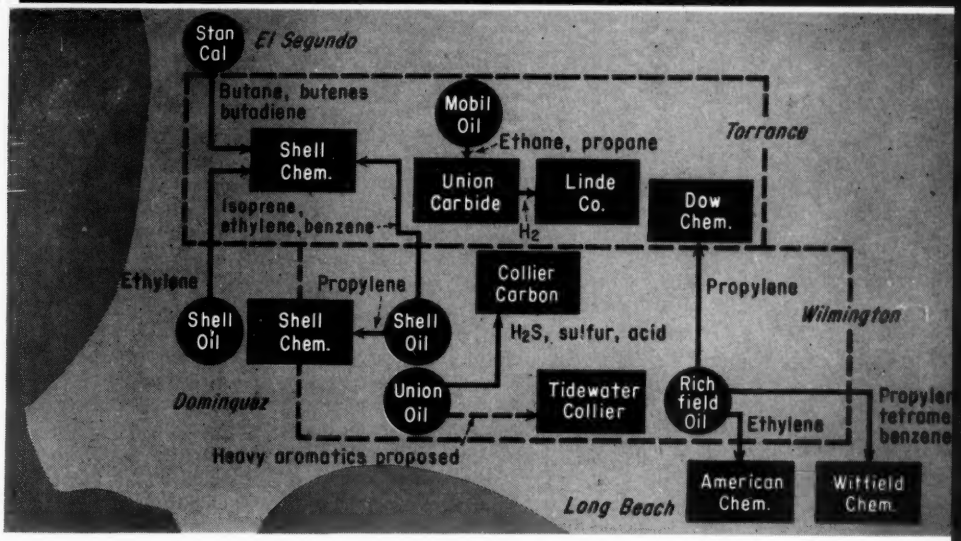
Most observers believe that no major move in petrochemicals in the Bay area will come until the latter half of the decade. An ethylene plant, for example, could probably find four or five customers, such as a linear polyethylene plant, but the smallest economically sized ethylene unit is around 100 million lb./yr., which is more than will be needed for some time. Much the same situation exists with propylene. There is not enough demand for polypropylene and propylene oxide-glycol to justify a high-purity propylene unit.

Los Angeles

One of the big hopes of petrochemical planners in southern California is the establishment of a basic textile manufacturing industry. Even though there is a growing garment manufacturing business in Los Angeles, the only basic textile weaver in California is the San Quentin penitentiary. Thus, as R. G. Luskin of American Chemical Corp. notes, hope for an expanding textile industry seems to rely on an upsurge in the crime rate.

The Chamber of Commerce and the City of Los Angeles have made extensive efforts to attract textile plants to the West Coast. But they seem stymied by the old chicken or egg proposition: availability of synthetic fiber plants might conceivably attract textile mills to the area, but no firm is going to build a fiber

Los Angeles already has building blocks — Fig. 9



Capacity of Major Refineries Around Los Angeles, Bbl. Day

Mobil Oil Co., Torrance	128,000
Richfield Oil Corp., Watson	173,000
Shell Oil Co., Wilmington-Dominguez	70,000
Standard Oil Co. of Calif., El Segundo	150,000
Union Oil Co. of Calif.	115,000

plant until it is assured of an existing textile market.

Production of acrylic fibers would hinge on a source of low-cost acetylene. Right now, there is no chemical-grade acetylene produced in the West. The Wulff Process unit, which turns out 1 million lb./yr., markets its acetylene for use in welding. But even with the advent of Canadian natural gas, there seems to be little chance of a petrochemical-acetylene plant being built without a guaranteed outlet in the textile business.

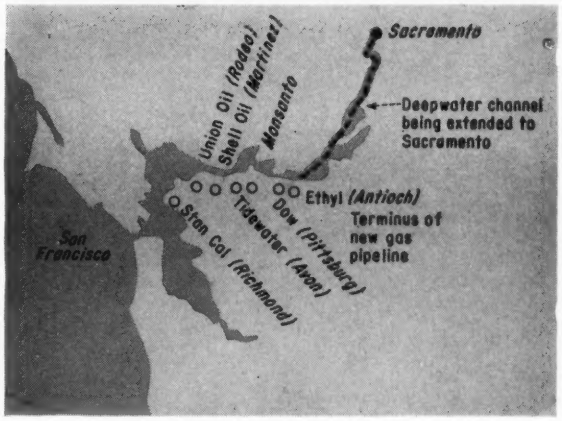
According to American Chemical's Luskin, the prospects for the petrochemical buildup in southern California rest upon the increase in consumer goods manufacturing. Despite the steady growth of plastics fabricating, for example, there is still much finished plastic material being shipped in from the East. If a larger plastic fabrication industry materializes, it in turn can support a substantial petrochemical complex extending all the way back to the basic building blocks.

As an index of the rapid growth that the plastics fabricating industry is enjoying, Los Angeles' Union Bank estimates that the industry in southern California will experience its most profitable year yet in 1961. Proof is that some $18.8 million worth of capital expansion in plastics was announced in Los Angeles County during 1960.

A nylon tire cord plant is also a distinct possibility for the Los Angeles area. There are presently four major tire manufacturers there: U. S. Rubber, Firestone, Goodyear and Goodrich. In addition, Armstrong is building a large tire plant in Hanford, Calif., and General Tire is also said to be considering a plant in the area. Assuming that rayon would supply half of the tire cord needs, there still would be a market for 15-20 million lb./yr. of nylon—enough to support a plant at an economic level of production.

Several chemical pipelines already exist in southern

Petrochemical nucleus in San Francisco — Fig. 10



Refinery Capacity, Bbl./Day

Shell Oil, Martinez	58,000
Standard of Calif., Richmond	210,000
Tidewater Oil, Avon	142,000
Union Oil	48,200

California (see Fig. 9). In addition, there is considerable chemical interchange by rail and water.

So What's Ahead?

Going into the economic upturn of the second half of 1961, chemical company sales are picking up nicely, but earnings are generally lagging behind last year's. This is symtomatic of ills that are most pronounced in the petrochemical industry: overcapacity, lowered prices, keen competition between different chemical products.

With the present level of plant construction in petrochemicals, there is little relief in sight for the embattled competitors. Some are even suggesting that this "shakedown" period could become a "shakeout," with newcomers that are not cut out for the chemical business withdrawing from the field.

On balance, it appears that the companies faring best in petrochemicals will be those that are not content merely to produce chemicals. Successful companies will be thinking in terms of new products (which are getting harder to find), new uses for old products, better customer service and improved marketing efforts. As a consequence, demand for chemical engineers in service and sales efforts will probably increase in relation to the other functions such as design, construction and production.

As discussed throughout the report, the interplay between technical and economic forces is becoming more complex, making forecasting a hazardous business. However, certain trends can be projected into the future of the petrochemical industry:

- Overcapacity (market for less than 85% of total industry capacity) exists in every volume synthetic organic and will probably continue for several years.
- Profit levels will be lower for both the chemical newcomers and the old-line firms.
- Oil companies, with idle refinery capacity and idle cash, will keep looking for more ways to upgrade raw hydrocarbons into chemicals.
- More chemical companies will integrate back toward hydrocarbon raw materials, some by purchasing small oil refineries.
- To fight new competition, old-line chemical companies will stress customer service, product tailoring.
- Petrochemical companies will integrate forward, buying plastic molders and converters, to gain greater control over their product distribution.
- Other companies (e.g., textile firms) that are now large chemical consumers may participate more actively in the chemical industry.
- With shifting raw-material economics and demands for faster product deliveries, petrochemical plants located away from the Gulf Coast will be more common.
- Engineering emphasis will be on lower production costs, search for more-direct processes.

The next five years are going to present a difficult—but potentially rewarding—challenge to those companies that have chosen to battle in the petrochemical arena.

ACKNOWLEDGMENTS

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The information for the graph on the first page of this article was furnished by Cities Service Co. That for Fig. 5 came from Chemical Project Associates.

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Meet the Author

ROLAND A. (CLEM) LABINE *has been on the staff of CE since 1957, when he graduated from Yale with a B.S. in chemical engineering. While at college, he worked summers for Monsanto Chemical and Atlantic Refining.*

If the style of this report has a familiar ring, it's not surprising. Clem either writes or rewrites everything that appears in the pages of "Chementator," one of the most widely read departments of the magazine.

Clem is a member of AIChE (he's chairman of the student guidance committee of the N. Y. Section), ASME and TAPPI.

CE is very proud of Clem's winning an Associated Business Publications' Jesse H. Neal Editorial Achievement Award for his article, "The Truth About Industrial Spying" (Chem. Eng., Feb. 22, 1960, p. 121.).

According to the biographical fact sheet, his interests are listed as, "collecting babies (two so far), guns and model trains." Baby 1, a boy, is 2½ years old; Baby 2, a girl, was born on July 17.

Articles in This Series

1. Designing laminar-flow systems, June 12, 1961, p. 243.
2. Determining end of laminar region, June 26, 1961, p. 127.
3. Turbulent flow—a historical review, July 10, 1961, p. 147.
4. Designing turbulent-flow systems, July 24, 1961, p. 143.
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6. Best methods for obtaining flow data, Aug. 21, 1961, p. 119.
7. **Interpreting and Converting Data.**

Interpreting and Converting Data

Here is how to tell whether your material is a Bingham, pseudoplastic or dilatant fluid. Also, how to get the most out of rotational viscometers.

RICHARD LeBARON BOWEN, Jr., *Coated Textile Mills, Inc.**

When using the scaleup methods for non-Newtonian flow (discussed in Parts 1-6 of this series) an engineer has to know very little about the rheological properties of the material under test. It can be a viscous Newtonian or any of a wide variety of non-Newtonians. It is only necessary to know whether or not the material is time-independent.

What Type of Fluid?

However, in some cases, it is valuable to know whether you are dealing with, say, a Bingham plastic or a pseudoplastic.

It is not difficult to place a material in one of the general rheological classifications (see Figs. 19 and 20). A τ vs. (dv/dr) diagram must be obtained either directly with a rotational viscometer or by converting $8V/D$ vs. $D\Delta P/4L$ data to τ_w vs. $(dv/dr)_w$, which is the true shear diagram on rheogram. (The integrated conditions for flow in a pipe specifically represent conditions at the wall of the pipe, so shear rate should actually be designated by $(dv/dr)_w$ and shear stress by τ_w.)

Let us assume we have $8V/D$, $D\Delta P/4L$ data. For Newtonian fluids, the shear diagram is the $D\Delta P/4L$ vs. $8V/D$ diagram, since $8V/D$ equals $(dv/dr)_w$ for Newtonian fluids ($\tau_w = D\Delta P/4L$ holds for all fluids).

This can be proved mathematically by several methods. The easiest way is to use Eq. (11) from Part 1:

$$(dv/dr)_w = [(3n' + 1)/4n'](8V/D)$$

where n' becomes equal to unity for Newtonian fluids.

Also, for Newtonian fluids, we have the relationship:

$$g_c\tau = \mu(dv/dr) \qquad (47)$$

that can be integrated by substituting $\tau_w = r\Delta P/2L$ to get[1]

$$8V/D = g_c D\,\Delta P/4L\mu = g_c\tau_w/\mu \qquad (48)$$

This is the familiar Poiseuille equation. Inspection shows that the left side of Eq. (48) equals the wall (dv/dr).

If the material is a Newtonian fluid, a logarithmic plot produces a straight line with a slope of 1 (Fig. 19). On an arithmetic plot, data fall on a straight line that passes through the origin (Fig. 20). It should be noted that suspensions of solids in liquids are very often Newtonian if the solids content is below 10% by weight.[2]

What About Non-Newtonians?

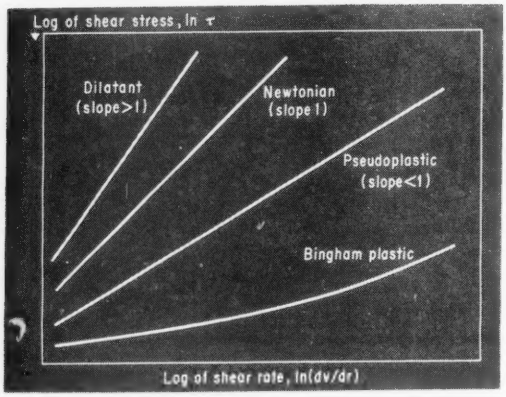
When the material does not have Newtonian characteristics, it is necessary to calculate rate of shear $(dv/dr)_w$ from Eq. (11). To do this, calculate slope n' from a logarithmic plot of $D\Delta P/4L$ vs. $8V/D$ data. (Logarithmic slopes are simply an arithmetically measured height divided by length.)

If the $D\Delta P/4L$ vs. $8V/D$ data fall on a straight line, n' is constant so $(dv/dr)_w$ simply represents $8V/D$ times a constant $(3n' + 1)/4n'$. Thus, the shear diagram will have the same slope as the $D\Delta P/4L$ vs. $8V/D$ curve. This indicates that it obeys a power law equation such as

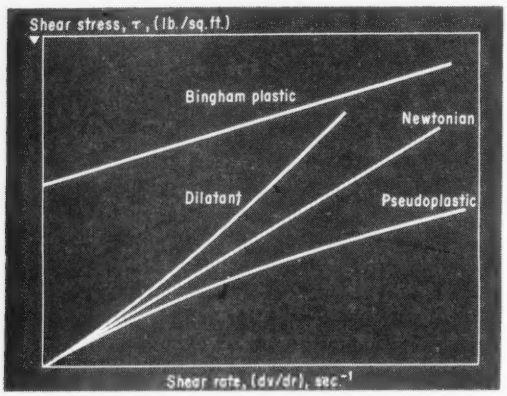
$$g_c\tau = K^*(dv/dr)^n \qquad (49)$$

where n is the new slope (nevertheless equal to n'). If this slope is less than unity and the data produce a straight line on a logarithmic plot, the material falls into the large group of materials called pseudoplastic materials (Fig. 19). Many polymer solutions, some slurries, and a variety of other materials, belong in

*For author biography, see *Chem. Eng.*, June 12, p. 248.



Log plot helps to determine type of non-Newtonian fluid—Fig. 19



On arithmetic plot, Bingham fluid shows up as straight line—Fig. 20

this group. If the curve has a slope greater than unity, the material is dilatant.

Not on a Straight Line

When a logarithmic plot of the $D\Delta P/4L$ vs. $8V/D$ data does not yield a straight line, take the slope of the tangent at a number of values of $8V/D$ and use these specific values of n' for calculating $(dv/dr)_w$.

It is very difficult to determine point slopes of a curve accurately by drawing a tangent. But a mirror, silvered on the front face to prevent parallax, is very useful for finding slopes.[3] And it is a good idea to plot the numerical values of the slopes against the values of $8V/D$, then draw a smooth curve, and use the slopes indicated by this curve. This will tend to eliminate any gross errors.

If a logarithmic plot of the $D\Delta P/4L$ vs. $8V/D$ data does not produce a straight line, the τ vs. (dv/dr) log plot will probably not be a straight line. But on arithmetic coordinates, the plot may produce an almost perfect straight line that intersects the τ axis. Such a material is a Bingham plastic (Fig. 20), and obeys the equation proposed by Bingham.[4, 5]

$$\tau = \tau_y + \mu_p(dv/dr)/g_c \qquad (50)$$

where τ_y is yield stress (intercept at the τ axis) and μ_p is plastic viscosity. Many suspensions and slurries appear to follow Bingham behavior perfectly (within experimental error). Some pigment dispersions also act similar to Bingham materials.

New Class of Plastics

Recently a new class of plastic materials has been proposed by Casson.[6] These materials are described by:

$$\tau^{0.5} = k_1 + k_2(dv/dr)^{0.5} \qquad (51)$$

The equation was derived by assuming that particles in a flocculated suspension form chain-like groups whose dimensions control viscosity. No experimental evidence has been produced to substantiate such a condition. However, the equation does appear to fit the behavior of a number of pigment dispersions over a range of shear-rates from 10 to 1,000 sec.$^{-1}$.

If the square roots of τ and (dv/dr) are plotted arithmetically, a straight line results. An arithmetic plot of τ vs. (dv/dr) yields a curve that bends towards the origin. The pigment dispersion used to outline the scaleup procedure in laminar flow (Part 1 of this series) is such a material. Both logarithmic and arithmetic plots of τ vs. (dv/dr) yield curves; but when the square roots are plotted, an almost straight line is produced (Fig. 21).

Converting Flow Data

We have stated in Part 6 that, in general, the extrusion rheometer is superior to the rotational viscometer for obtaining laminar $D\Delta P/4L$ vs. $8V/D$ data. This is due to the difficulty of deriving an equation in terms of $8V/D$ from one in terms of (dv/dr).

However, it can be done. Mathematically, there are two ways to approach the problem. Both depend upon a relationship between shear-stress and shear-rate:

$$(dv/dr) = \phi(\tau) = \phi(r\,\Delta P/2L) \qquad (52)$$

This can be integrated twice to give the double integral:[7]

$$q = \frac{V\pi D^2}{4} = \int_0^R \int_0^r \phi(\tau)\, dr \cdot rdr \qquad (53)$$

Integration of this equation produces an expression that can be arranged in terms of $8V/D$ and $D\Delta P/4L$. In some cases, a suitable substitution may be made so that $8V/D$ is expressed directly in terms of (dv/dr), as we shall see. When the relationship in Eq. (52) cannot be expressed analytically, the required double integration may be carried out graphically. Or the relationship of Eq. (52) could be substituted into

Eq. (11) and the resulting equation integrated to give an equation in terms of $8V/D$ and $D\Delta P/4L$.[7]

Power-Law Fluids

If a fluid obeys the power law, τ vs. (dv/dr) data conform to Eq. (49). This may be integrated via Eq. (53) to give:[1]

$$q = \frac{V\pi D^2}{4} = \frac{\pi D^3}{8}\left(\frac{n}{3n+1}\right)\left(\frac{g_c\tau_w}{K^*}\right)^{1/n} \qquad (54)$$

This gives the pipeline relationship in terms of K^* and n of Eq. (49). However, rearrange the equation and substitute (dv/dr) from Eq. (49) to give:

$$8V/D = [(4n/(3n+1)](dv/dr) \qquad (55)$$

This equation is identical with Eq. (11), except n is a constant. However, there is one very important difference: while Eq. (11) is rigorous for all types of fluids, Eq. (55) can be used only for power-law fluids.

If it were known in advance that the fluid under investigation was a pseudoplastic (or dilatant) obeying the power law, the easiest way of obtaining a $D\Delta P/4L$ vs. $8V/D$ diagram would be from a τ vs. (dv/dr) diagram obtained by using a rotational viscometer.

If the material is a Bingham plastic, τ vs. (dv/dr) data will obey Eq. (50), which can be integrated to produce the following well-known flow relationship:

$$\frac{8V}{D} = \frac{g_c}{\mu_p}\left(\tau_w - \frac{4}{3}\tau_y + \frac{\tau_y^4}{3\tau_w^3}\right) \qquad (56)$$

How to Handle Bingham Plastics

This is the Buckingham equation.[8] The relationship $\tau_w = D\Delta P/4L$ could be substituted into Eq. (56), but it is impossible to solve the equation specifically for the pressure loss (or τ_w) in pipeline scaleup.

Working from the Buckingham equation, McMillen introduced a few dimensionless quantities and considerably simplified the pressure-drop calculation for laminar flow with the equation:[9]

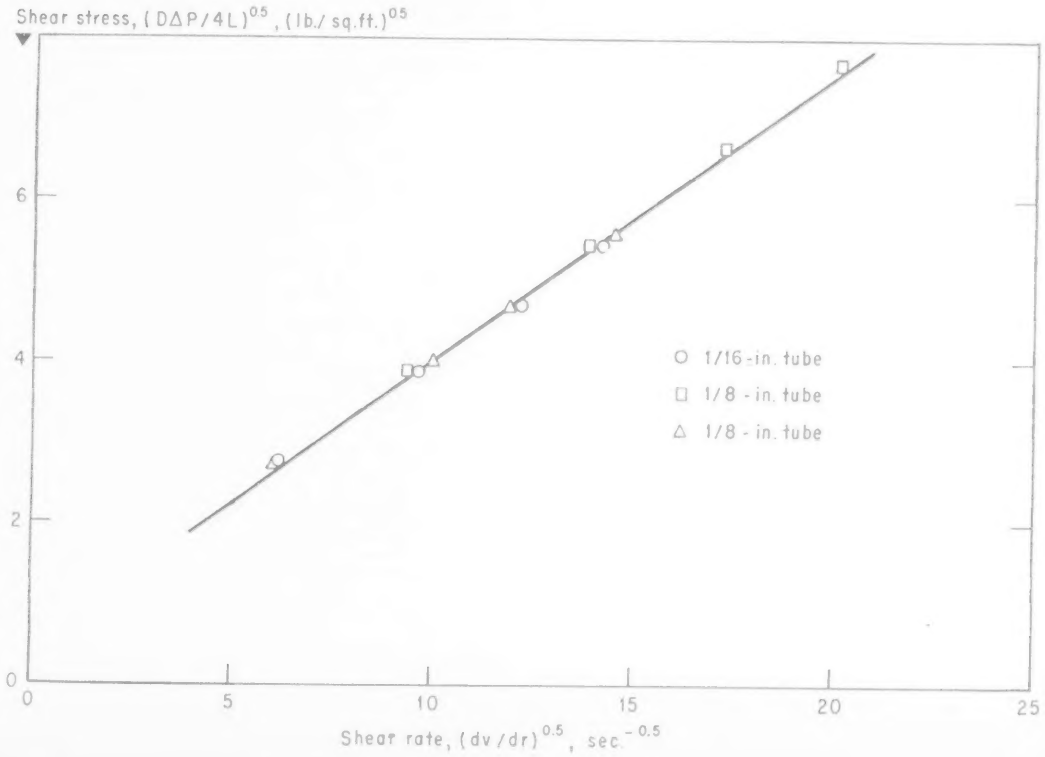
$$\Delta P/L = 4\tau_y/Dg' \qquad (57)$$

where g' is determined graphically from McMillen's plot using the quantity $2V\mu_p/D\tau_y$.

Govier and Winning applied dimensional analysis to the problem of Bingham plastic flow, and showed that laminar flow should be shown on a Reyonlds number chart by a number of parameters represented by the plasticity number $Y = g_c\tau_y D/V\mu_p$, when the plastic viscosity μ_p is used in the Reyonlds number.[10, 11, 12]

Hedstrom also applied dimensional analysis to the

Square-root correlation works for pigment-oil suspensions—Fig. 21



problem, and showed that in addition to the plasticity number, Bingham plastics should also be represented by parameters of the Hedstrom number $g_c\tau_y D^2\rho/\mu_p^2$ on a Reynolds number chart, when μ_p is used in the Reynolds number.[13] If the data were plotted on a Reynolds number chart, data for various pipe sizes would fall on Hedstrom's parameter, while the plasticity number parameters will include points of all pipe sizes.

Pick Shear-Stress Values

These relationships, based on the Buckingham integration of Bingham's Eq. (50), seem to be of interest only if viscometric data are in the form of a τ vs. (dv/dr) curve obtained with a rotational viscometer.

Most prior-art work on Bingham plastics has been directed towards presenting the data on a Reynolds number chart. This is possibly justified as a means of correlating the data. However, to use these charts, you must enter a parameter with a value of the Reynolds number, find the friction factor and then calculate pressure drop.

There is a much simpler means of laminar pipeline scaleup for Bingham materials obeying Eq. (50). Values of τ_w are arbitrarily picked, and substituted into Eq. (56) along with the constants τ_y and μ_p to get values of $8V/D$. If these data are plotted, we obtain a $D\Delta P/4L$ vs. $8V/D$ relationship directly.

However, it is not actually necessary to plot the data. Values of $D\Delta P/4L$ and $8V/D$ can be used directly to obtain values of $\Delta p/100$ ft. and Q (gpm.) for the pipe-flow chart discussed in Parts 1 and 4. This produces a much more satisfactory graphical presentation of the pipe-flow conditions than any trial-and-error calculations using a Reynolds number chart.

Extrusion Rheometer Best

A word of caution should be injected here, regarding Bingham plastic fluids. Bingham's ideal body must fit Eq. (50) perfectly. Data must lie on a perfectly straight line that intersects the τ axis. However, there has been considerable dispute over the linearity of actual fluids that seem to approximate Bingham materials. Many investigators have found that, while the shear diagram is linear at higher rates of shear, it tends to bend towards the origin at lower rates.[11] This problem is made more difficult because the viscometer spindle can definitely "slip" at lower shear-rates—proved by roughening the surface of the viscometer spindle and comparing it with smooth ones.[14]

If the τ vs. (dv/dr) data do not produce a straight line at lower shear-rates, the Buckingham Eq. (56) cannot be used for the nonlinear part of the curve. It may be used for the straight part of the shear diagram, and the intersection of the straight line on the τ axis must be used for the value of τ_y.

Since viscometric data have to be initially collected in all such cases for these plastic materials, it is better to collect data in an extrusion rheometer. This will give the $D\Delta P/4L$ vs. $8V/D$ plot directly without worrying about the problem of how to handle yield stress.

Many suspensions and slurries approximate Bingham behavior very closely in higher concentrations. We have pointed out that below 10% they are probably Newtonian. Many pigment dispersions also act like Bingham bodies.

Handling Casson Fluids

If the material obeys the Casson relationship, Eq. (51) will describe the τ vs. (dv/dr) data. This equation may be integrated by means of Eq. (53) to produce something similar to Buckingham's Eq. (56), although considerably more complicated.

The equation could be used to obtain a $D\Delta P/4L$ vs. $8V/D$ relationship. However, the pigment dispersions that appear to be represented by such a relationship seem to curve towards the origin at lower shear-rates. Also, it is very difficult to get reproduceable data with

Nomenclature

d	Diameter of rotational viscometer spindle, ft.
D	Pipe or tube diameter, ft.
g'	Function in Eq. (57).
g_c	Gravitational constant, 32.2 (ft./sec.)/sec.
h	Length of rotational viscometer spindle, ft.
k	Constant in turbulent correlation equations, such as Eqs. (34) and (38).
k_1, k_2	Constants in Eq. (51).
K	Fluid consistency index defined by Eq. (1).
K^*	Fluid consistency index defined by Eq. (49), so $K^* = g_cK$.
L	Pipe or tube length, ft.
n	Non-Newtonian rheological constant defined by Eqs. (1) and (49).
n'	Non-Newtonian rheological factor defined by Eqs. (11) and (22).
n''	Non-Newtonian rheological constant defined by Eq. (59) equal to the slope of a logarithmic plot of τ vs. N.
N	Speed of rotational viscometer, rev./min.
ΔP	Pressure drop, lb./sq. ft.
Δp	Pressure drop, psi.
q	Flow rate, cu. ft./sec.
Q	Flow rate, gpm.
r	Radial or linear distance, ft.
T	Instrument torque, ft.-lb.
v	Local velocity at r, ft./sec.
dv/dr	Local velocity gradient or rate of shear in pipeline or in a rotational viscometer, sec.$^{-1}$.
$(dv/dr)_w$	Shear rate at the wall of a pipe or tube, sec.$^{-1}$.
V	Mean linear velocity, ft./sec.
$8V/D$	Shear rate of a Newtonian fluid at the wall of a pipe (laminar flow) or flow function for non-Newtonian fluids, sec.$^{-1}$.
x	Constant in turbulent correlations, Eqs. (39) and (40).
ρ	Density, lb./cu.ft.
τ	Shear stress, lb./sq.ft.
τ_w	Shear stress at the pipe or tube wall, equal to $D\Delta P/4L$, lb./sq.ft.
τ_y	Yield stress of a Bingham-plastic fluid, lb./sq.ft.
μ	Viscosity of a Newtonian fluid, lb./(sec.)(ft.), equal to $g_c\tau/(dv/dr)$.
μ_p	Viscosity of a Bingham-plastic fluid, lb./(sec.)(ft.).
ϕ, ϕ'	Indicators of unspecified functional relationships.

a rotational viscometer for such materials. Here it would appear advisable to use the extrusion rheometer to collect viscometric data.

If a τ vs. (dv/dr) diagram does not fit any of the classic equations for ideal bodies, it is still possible to obtain a $D\Delta P/4L$ vs. $8V/D$ curve by a graphical manipulation.

As a start, divide values of (dv/dr) by the point value of $(3n + 1)/4n$. If the τ vs. (dv/dr) diagram should curve on logarithmic coordinates, the new curve will be displaced from the true τ_w vs. $8V/D$ curve in proportion to the magnitude of the curve. But the difficulty can be overcome by trial and error.

First, take the slopes at a number of points on the τ vs. (dv/dr) plot and calculate $(3n + 1)/4n$. Then, divide the (dv/dr) values by various $(3n + 1)/4n$, and plot this calculated "$8V/D$" vs. τ_w values for the various points. This produces a $D\Delta P/4L$ vs. $8V/D$ curve that is displaced from the true curve: if the τ vs. (dv/dr) diagram curves upward, the calculated $D\Delta P/4L$ vs. $8V/D$ curve will be slightly lower than the true curve; if it curves downward, this calculated curve will be slightly above the true curve.

The greater the curve in the original τ vs. (dv/dr) diagram, the greater the error. If the original curve is flat at either end, the calculated curve will be found to be exact at that extremity.

As a second step, establish a τ vs. (dv/dr) diagram from the calculated $D\Delta P/4L$ vs. $8V/D$ curve using specific values of $(3n' + 1)/4n'$ taken from the new curve. This third curve will not agree with the original τ vs. (dv/dr) curve—it deviates in part or completely. Now draw a fourth curve next to the calculated $D\Delta P/4L$ vs. $8V/D$ curve, 5 or 10% above or below it in the areas where it deviated. From this fourth curve, calculate a fifth τ vs. (dv/dr) curve. This will lie closer to the original curve (or perhaps the correction will place it on the other side of the original).

About Rotational Viscometers

There are a number of variable-speed rotational viscometers for obtaining τ vs. (dv/dr) data.[15]

Modified MacMichael and Stormer coaxial viscometers are well known, while the newer plate-and-cone viscometer is finding wide use. However, by far the simplest instrument is one with a single spindle that rotates in what amounts to an infinite mass, such as the Brookfield Synchro-Lectric, the Haake, or the Rotovisco viscometers.

Simplicity of this type of instrument makes it worth describing. In practice, the receptacle holding the fluid has to have a large diameter so container walls do not affect any instrument reading. In general, the greater the viscosity, the larger the container; and the higher the instrument speed, the larger the container.

It is very important to be sure that the container walls do not affect torque readings, since this will obviously produce anomalous results. A number of readings should be taken in different-diameter containers at the maximum instrument speed to determine minimum container size.

The Brookfield Synchro-Lectric is normally supplied with spindles consisting of slender shafts having single disks mounted near the ends. The instrument will give the viscosity of a Newtonian fluid in centipoises using any spindle and any instrument speed (within the limit of the instrument torque). However, it is impossible to obtain rational results on non-Newtonian fluids with disk spindles. A few cylindrical spindles are supplied by the manufacturer, but some of these have a complicated end geometry that makes it difficult to calculate actual shear-stress.

Make Your Own Spindles

Generally, experimenters make a set of cylindrical spindles that can be used with the usual calculations.

The assumption implicit in these calculations is that shearing stresses are confined entirely to the cylindrical surface of the spindle, i.e., that there are no end effects. A cylindrical spindle only has one end effect if the cylindrical section projects out of the liquid at its full diameter. However, since it is very difficult to maintain such a spindle at a uniform immersion in the fluid, a considerable experimental error can be introduced.

Often the diameter at the top is reduced as much as possible and the spindle leaves the fluid at a much reduced diameter, so the spindle has two ends to consider. Usually, end effects are corrected by use of an "equivalent length" that is somewhat longer than actual cylindrical length. This equivalent length is calculated using actual diameter by calibrating the spindle in a Newtonian fluid of known viscosity, such as those from the National Bureau of Standards.

Application to non-Newtonian fluids, of equivalent lengths as determined with a Newtonian fluid, is questionable. But excellent results have been obtained for equivalent lengths as much as 20% greater than the actual cylinder length, for fluids with an n as low as 0.20.[16] However, for accuracy, the length to diameter ratio must be kept as great as practical.

Calculating Shear Stress and Rate

The shear-stress at the wall of a cylindrical spindle is very easily calculated:

$$\tau = \text{force/area} \tag{58}$$

$$\tau = \frac{T}{(d/2)} \times \frac{1}{\pi dh} = \frac{2T}{\pi d^2 h}$$

where T is instrument torque, and d and h are cylinder diameter and height. For a viscometer with an infinite ratio of cylinder diameter to container diameter (container walls do not effect the torque), rate of shear at the wall of the cylinder is given by:[17]

$$dv/dr = 4\pi N/60n'' \tag{59}$$

where N is rotational speed in revolutions per minute and n'' is slope of a logarithmic plot of instrument torque vs. N. This equation is rigorously applicable to all fluids, n'' does not have to be constant.[2]

If the fluid obeys the power law, then $n'' = n = n'$. In this case calculation of the shear stress vs. shear rate diagram is precise since N is simply multiplied by a constant in Eq. (59) to obtain shear-rate.

Also the $D\Delta P/4L$ vs. $8V/D$ curve obtained from the shear-stress diagram is exact, as outlined above.

For power-law fluids, data for pipeline scaleup in the laminar region can best and most easily be developed with a rotational viscometer, provided high shear-stresses can be obtained at the maximum instrument speed.

However, if the rotational viscometer data describe a curve on a logarithmic plot, then n'', n, and n' all have different values at each value of τ. Here, precise determination of the slopes is very difficult, as we have pointed out. Once the τ vs. (dv/dr) is available, the graphical trial-and-error method outlined above is required to get a $D\Delta P/4L$ vs. $8V/D$ diagram, if the data do not fit one of the classical equations.

Where data do not represent one of the classical fluids, the extrusion rheometer is superior to a rotational viscometer for pipeline scaleup.

Big Difference in Instruments

Consideration of Eq. (59) reveals a basic difference between the rotational viscometer and the extrusion rheometer. Whereas shear-stress is the controlled variable with the rheometer, shear-rate is usually varied in the rotational viscometer.

Rotational instruments operating on the infinite-mass principle are usually supplied with a maximum speed of 100 rpm., which would give a (dv/dr) of $20.9/n''$, or values of 20.9 to 100 sec.$^{-1}$ for values of n'' from 1.0 to about 0.2. However, instruments with maximum speeds of 600 rpm. can be supplied, increasing the maximum values of (dv/dr) to 100 to 600 sec.$^{-1}$. Only if the material is very viscous can high shear-stress for pipeline scaleup be obtained with a rotating spindle instrument.

Some Design Recommendations

We have presented methods for non-Newtonian pipeline scaleup, in such a way that an engineer does not have to know anything about the rheology of the system under study.

Methods of scale-up presented in this series automatically consider viscosity of the material so it does not have to be considered separately.

Generally, an engineer cannot tell at the start whether he will want to design in the laminar or turbulent region. Since our turbulent scaleup methods call for obtaining a laminar flow curve, laminar data is first collected in an extrusion rheometer (or rotational viscometer for power-law fluids).

It must be proved that the fluid is not time-dependent or otherwise anomalous by obtaining data with at least two different tube lengths (of the same diameter) and two diameters (of the same length). If all these data correlate on a $D\Delta P/4L$ vs. $8V/D$ diagram, the smooth curve can be used for constructing pipe-flow charts.

Absence of turbulence on the pipe-flow charts must be assured by calculating the Reynolds number for the largest pipe at the highest flow. If the pipe-flow chart produces the desired information, the problem is solved.

However, if fluid consistency is low so it is in the turbulent region, turbulent data must be collected from actual pipeline tests.

These data are placed on a logarithmic plot of $D\Delta P/4L$ vs. $8V/D$ along with laminar data. The turbulent branches for various pipe sizes will in all probability form straight lines. These turbulent data are then correlated as $D^{(1+x)}\Delta P/4L$ vs. V. With this correlation, turbulent pipe-flow curves can be drawn for various pipe sizes.

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6 Quick Ways Statistics Can Help You

Tests:
1. The Outside Count Test
2. The Sign Test
3. The Corner Count Test

Estimates:
4. Two-Point Estimate of the Mean
5. Quick Estimate of Standard Deviation
6. Straight Line of Best Fit

B. S. BROWN, *E. I. du Pont de Nemours & Co.*

Every practical man faces the problem of evaluating ideas. He must do it on the basis of data gathered to assist him.

Production data, for example, are examined to evaluate the idea that a chemical process is operating well. Experimental data are examined to evaluate the idea that a new product will be profitable if it is commercialized. Sales data are examined to evaluate the idea that a new sales pattern has developed.

Whenever data are presented, an implicit question is asked. "Do these data justify an optimistic or a pessimistic view of the idea?"

Sometimes the answer is simple, and sometimes it is difficult. Predetermined points of view may cause different people to come to different conclusions after examining the same data. One person is more impressed by the absolute level of the data. Another is more impressed by the spread of the data. Still others may overemphasize or ignore unusual observations. Almost any data, if pushed and pulled enough, can be made to support almost any conclusion.

On-the-Scene Statistics

Clearly, consistent and impartial ways are needed for looking at data. Trained in the selection and use of such methods, the statistician offers methods as time-consuming and intricate as they are specific and precise. Statistically trained personnel aren't often on the scene when practical data evaluation is undertaken, either, and there is usually no time to consult them. In such cases, inferences are drawn and decisions made without statistical assistance.

For use anywhere and any time, a portable set of quick, statistical tools is provided in this article. It is recommended for use by engineers when statistical methods wouldn't normally be used—either because of the additional time or extra effort required. Quick, easy and widely applicable, these statistical tests require that you remember only simple counting procedures plus three "magic" numbers (significance levels)—2, 7 and 11. Associated with a well-known game involving spotted cubes, the latter two of these numbers are easily recalled.

The techniques described in this article are based upon nonparmetric statistics—a set of statistical methods that make no assumptions about the specific distributions from which data are drawn.

These methods use the information contained in the order of the observations—from smallest to largest—rather than the numerical value of the observations. Two advantages accrue:

• Wide applicability. No assumptions are made about distribution of the data. Hence, these methods

How two statisticians look at fiber data—Table I

Optimist: "Not only batch superiority; also over-all."

Fiber A		Fiber B
3.0		4.2
4.1		5.0
4.6		6.5
4.9		6.9
6.5		7.2
7.3		9.0
5.1	◀Averages▶	6.5
	Difference, B — A:	1.4
	Required difference	1.0

Pessimist: "Only one item in B better than A."

Fiber A	Fiber B
3.0	
4.1	
	4.2
4.6	
4.9	
	5.0
6.5	6.5
	6.9
	7.2
7.3	
	9.0

can be applied to samples of independent observations from any distribution.

• Ease of computation. Most of the arithmetic is replaced by simple counting procedures.

The six techniques given here can be grouped into two sets, the tests and the estimates. To the question, "Is this idea (or hypothesis) reasonable?", the tests give a "yes" or "no" answer. The estimates provide a best guess as to the value of a number (or parameter) that summarizes and describes the data. Usually we use a test first. Only then, if the results indicate that the data are still interesting, do we use one or more estimates to characterize the data more compactly.

The tests given in this article have been keyed to a 5% level of significance. Thus, it will be wrong to say that a significant difference or correlation exists when (on the average) there is none 5% or fewer of the occasions that the test is used. Although the 5% level of significance is recommended as a practical one for quick statistics, Table IV shows alternative significance levels to give you a feeling of their criticalness in these tests. (If the precise level of significance is an issue in a given problem, more-efficient techniques should be used than those presented here.)

The Outside Count Test

A frequent problem that the engineer faces is to decide which of two ways of doing something is better, or whether two items are similar or different. Take an example.

A new fiber *B* has been proposed for a market now dominated by another fiber *A*. To justify moving to the next step in development, fiber *B* must be stronger in tensile strength than fiber *A* by at least one unit. From six laboratory batches of each fiber, results of tensile strength tests are:

• For *A*—4.9, 3.0, 6.5, 7.3, 4.6, 4.1

• For *B*—5.0, 9.0, 6.9, 4.2, 7.2, 6.5

The optimist presents his case (see Table I):

"Every value for fiber *A* is matched by a higher one for fiber *B*, and fiber *B* averages a clear 1.4 units better than *A*. Not only is *B* superior to *A*, but it has 40% greater tensile strength than we asked for. I think we should get the ball rolling on this one, pronto."

The pessimist rises and says that he thinks the data tell a more-revealing story when presented his way (also shown in Table I). Claims he:

"Both these fibers show a pretty wide spread, and you see only one batch (9.0) of fiber *B* is better than all the batches of fiber *A*. Take away that one, and *A* is just as good as *B*. In effect, we are putting all our eggs in one basket."

The traditional statistical test for this situation is the "Student's" t-test. It is rarely used by non-statisticians because of the computation that is required. For general use, the *outside count test* is proposed as a practical alternative to the "t-test."

A nonparametric test, the outside count test is based on the idea that the degree of overlap of two samples is a measure of how similar they are. The largest and smallest observations must be in different samples to use it.

Rules for the Outside Count Test

First, count the number of values in the sample containing the largest value, which are larger than the largest value in the other sample.

Next, count the number of values in the other

sample that are smaller than the smallest value in the first sample.

Third, add the two counts. (It is required that neither count be 0.)

Finally, if the two counts total 7 or more, the samples are different at the 5% level of significance.

Applying this test to the example above, we obtain the count, 1 + 2 = 3. With a count less than 7, these data do not show a clear superiority for fiber *B*. The classical computation—which took over ten times as long to carry out—confirms the result. The 95% confidence limits on the difference between the two fibers are −0.7 and 3.5. Since 0 is included within the limits, no difference between the two fibers is indicated.

A useful feature of the outside count test is that the two sample sizes need not be equal. But they must be within about 25% of each other, a ratio of 4:3. Thus, sample sizes of 10 and 12, or 23 and 18, could be tested without any change in the technique. Smaller differences can be detected with larger sample sizes, but for practical purposes, counting the items becomes increasingly difficult in samples larger than 30.

The Sign Test

The oldest and most widely used of quick, nonparametric statistical tests is the *sign test*. It can be used whenever the data can be divided naturally into two mutually exclusive groups.

Consider a chemical process that consists of two identical, parallel lines. They use feedstock from the same supply, and there is no apparent reason for them to perform differently. There is, however, a general opinion among people working with the process that the *B* side is easier to control, and generally runs better than the *A* side.

A technical study has been planned to find out why the *A* line doesn't operate as well as the *B* line. Before approving it, the technical manager asks to see some data which show the need for the study. The weekly percent yields of product for the past 48 weeks are listed for him in the middle two columns of Table II.

Observing that there are swings in the yield, the technical manager also notes that the two yields for a single week are closer than the yields from week to week. Since he is busy and wants to make a decision quickly, he doesn't call on a statistician for an analysis. He decides, instead, that the data are too "noisy" and rejects the proposal.

This example is ideally suited to the sign test, however. The data are naturally paired, two yields for each week. Whatever the changes that may occur from week to week, the process should be fairly stable for any one week, and each week can be considered a separate piece of information.

Weekly yield for application of sign test—Table II

Week	A Line %	B Line %	Sign
1	93.0	93.1	+
2	92.8	92.4	−
3	91.3	91.7	+
4	89.9	90.2	+
5	90.8	90.3	−
6	89.6	90.2	+
7	91.8	92.1	+
8	94.4	94.1	−
9	92.7	93.1	+
10	91.7	92.8	+
11	90.9	90.8	−
12	91.2	91.0	−
13	90.2	90.5	+
14	90.6	90.9	+
15	90.9	90.3	−
16	90.0	89.9	−
17	90.2	90.3	+
18	92.5	93.0	+
19	91.6	92.6	+
20	92.8	92.8	0
21	89.9	89.8	−
22	88.8	89.2	+
23	90.4	90.6	+
24	89.1	89.4	+
25	93.0	92.7	−
26	88.2	88.9	+
27	89.2	90.0	+
28	89.2	89.1	−
29	87.6	87.9	+
30	90.7	91.0	+
31	89.4	89.4	0
32	89.7	89.5	−
33	91.5	91.5	0
34	88.2	88.4	+
35	88.8	88.9	+
36	89.3	89.0	−
37	88.8	89.0	+
38	91.5	91.4	−
39	90.5	90.6	+
40	89.2	89.4	+
41	89.6	89.9	+
42	88.8	90.2	+
43	91.2	91.7	+
44	92.2	92.4	+
45	91.5	91.4	−
46	93.2	93.0	−
47	93.1	93.9	+
48	90.9	91.5	+
		Summary: "+"	30
		"−"	15
		"0"	3

Rules for the Sign Test

1. Assign a plus sign to each pair for which B is better than A.
2. Assign a minus sign to each pair for which A is better than B.
3. Count the plus signs.
4. Count the minus signs.
5. Compute D = (Number of plus signs) − (Number of minus signs).
6. Compute N = (Number of plus signs) + (Number of minus signs).

Compare the absolute value of D with $2\sqrt{N}$. If $|D|$ is greater than $2\sqrt{N}$, then there is a difference between A and B at the 5% level of significance. If the sign of D is positive, then B is better than A. If the sign of D is negative, A and B do not significantly differ.

Applying the sign test to the process example, we write down a plus sign beside each week that the B line yield is greater than the A line yield. For the weeks that the A line yield exceeds the B line yield, we write a minus sign. For the three weeks in which yields are identical, we write a 0.

Summing, we find 30 plus signs and 15 minus signs. Hence, $D = 30 - 15 = 15$, and $N = 30 + 15 = 45$. Compare 15 with $2\sqrt{45}$. Now, $\sqrt{45}$ is less than 7, so $2\sqrt{45}$ is less than 14. Thus, $D = 15$ is clearly greater than $2\sqrt{N}$. We say, therefore, that there is a difference between the two process lines at the 5% level of significance.

The long computation using the paired "t-test" gives 95% confidence limits on the difference in yield between lines A and B as 0.26 and 1.87. Since zero isn't included within these limits, the results of the sign test is confirmed.

Sometimes the user himself can construct the natural pairing required for the widely applicable sign test. For example, ten batches of polymer have been prepared by a new method (Table III). Are these batches consistent with an expected chloride value of 8.60?

To use the sign test here, we construct a pairing by matching each batch with expected value. Then we assign a plus to each value greater than 8.60 and a minus to each value that is smaller. With three plus signs and seven minus signs, $D = 3 - 7 = -4$ and $N = 3 + 7 = 10$. Now, 4 is less than $2\sqrt{10}$. There is no significant difference between expectations and results.

Sample Size for Sign Test

As can any other statistical test, the sign test is able to detect smaller differences with larger sample sizes. If the results of a particular application are not significant, we may want to know how much more data would be required for the observed ratio to be significant. The following formula gives an estimate of how many additional pairs would be needed.

1. If, in a sign test, D is less than $2\sqrt{N}$, use this formula.
2. Compute $N' = (2N/D)^2 - N$. This is the number of additional samples required.

In the chloride example of Table III, $D = 4$, $N = 10$. Thus, $N' = (20/4)^2 - 10 = 15$. We would have to make 15 more batches to demonstrate a ratio of 7:3 as significant.

Test batches by sign—Table III

Batch	Observed Chloride Value	Expected Chloride Value	Sign
1	8.61	8.60	+
2	8.54	8.60	−
3	9.66	8.60	+
4	8.62	8.60	+
5	8.00	8.60	−
6	7.01	8.60	−
7	7.36	8.60	−
8	7.81	8.60	−
9	8.04	8.60	−
10	8.43	8.60	−

The Corner Count Test

Another problem that engineers encounter frequently is that of judging suspected correlations. Data are often presented in the form of a scatter plot, from which a conclusion is drawn by visual inspection.

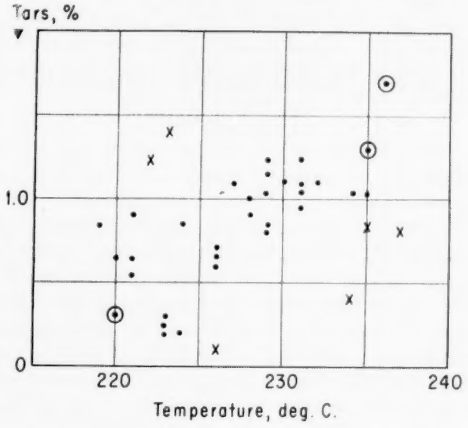
For example, in an industrial chemical process, a preheater is used to raise temperature of a feed stream closer to reactor temperature. To increase production rate, a proposal is made to raise preheater temperature. A theoretical analysis of the process indicates that yield losses in the form of a greater percentage of tars in the product should increase with temperature. Advocates of the proposal, however, suggest that it shouldn't really be detectable.

To settle the question, six weeks of daily-average data for preheater temperature and for product tar values have been taken from the record sheets and plotted in Fig. 1. The implicit question is asked: "Do these data justify an optimistic or pessimistic view about the idea that no important correlation exists between preheater temperature and tars?"

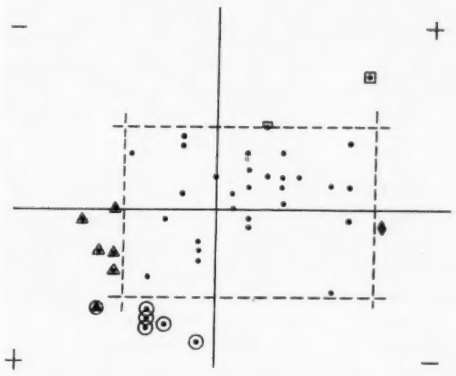
Says the optimist: "I see high tars and low tars at both high and low preheater temperatures. Since there is nothing but random variation in this plot, I think we should go ahead with the process change to increase production and preheater temperature now."

Says the pessimist: "I question the validity of these particular points." He marks them with an X and proceeds to point out his reasons—some of the data

What view do data justify?—Fig. 1



Corner count bolsters pessimist's—Fig. 2



were taken from a period of low-quality feed stock, some from startup operation, etc. Applying different reasons to different points, he discards all the points he questions, and concludes: "Now the correlation is clear; higher preheater temperatures make more tars. I think we should hold up any process change that would increase preheater temperature until we can be sure our refining facilities can handle these additional tars."

Replies the optimist: "If just a few points are discarded," (which he marks 0) "the graph looks like random scatter again." He, of course, justifies the discarding of points for process reasons, and so the argument sways back and forth—each participant with his own criteria of judgment, each with his own conclusions.

In this case, too, there is an accepted statistical technique for computation and testing for correlations. The computation takes an hour or so, however, on a desk calculator, and it is vulnerable to computational blunders. The *corner count test* is a quick, nonparametric test suited for this problem. It gives special weight to extreme values of the two variables, and is a two-dimensional analog of the outside count test.

Rules for the Corner Count Test

1. Construct a scatter diagram of the data.
2. Draw two lines parallel to the axes through the medians. The median is the observation that divides data into two groups, each with an equal number of points. (Note that the median dividing the data vertically is horizontal; the median dividing the data horizontally is vertical.)
3. Label the four quadrants formed with the signs +, −, +, −, beginning with the upper right and moving counterclockwise.
4. Record the following four counts:

a. beginning at extreme right, count inward along the horizontal axis toward the middle of the scatter plot until forced across the horizontal axis. Write down the number of points encountered before crossing the horizontal axis, and then attach the sign of the quadrant in which the points are located;

b. repeat the process for the extreme left, counting inward toward the right;

c. repeat for the extreme top, counting vertically downward;

d. repeat for the extreme bottom, counting vertically upward.

5. Sum the four counts with the algebraic signs.
6. If the absolute value of the sum is greater than 11, there is a correlation at the 5% level of significance. If the sign is positive, then the correlation is positive (the variables move together). If the sign is negative, the correlation is also negative (as one variable increases, the other decreases).

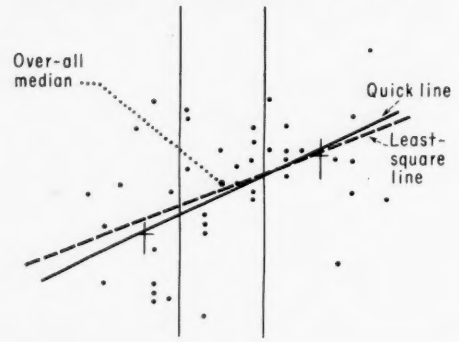
Applying the corner count test to the example of Fig. 1, we have drawn the medians and labeled the quadrants in Fig. 2. The four counts are:

- Right, −1.
- Left, +6.
- Top, +1½ (when two items are tied, count ½).
- Bottom, +6.

The sum is 12½, which is clearly greater in absolute value than 11. We are pessimistic about the idea that no relation exists between the two variables. The sign of the count is positive, indicating that higher temperatures and more tars occur together.

(Continued on next page)

Finding the best fit—Fig. 3



Two-Point Estimate of the Mean

There are occasions when even the computation of the mean requires too much work for the situation at hand. In such cases, an easily remembered two-point estimate of the mean is very handy. Often the computation can be done mentally. Two methods are given here, one for very small samples, and the other for small samples.

Rules for Two-Point Estimate of Mean

Take the arithmetic average of the two observations indicated below:

1. Very small samples ($N \leq 5$). Largest value, x_N, and smallest value, x_1.

$$\bar{x} = (x_1 + x_N)/2$$

This statistic has a special name—the midrange.

2. Small samples ($6 \leq N \leq 20$). Third-largest value, x_{N-2}, and third-smallest, x_3.

$$\bar{x} = (x_3 + x_{N-2})/2$$

For an example, consider the two fibers in the outside count example of Table I. What are the average values of tensile strength of each fiber?

Using the quick estimates, we obtain, for fiber A

$$\bar{x} = (7.3 + 3.0)/2 = 10.3/2 = 5.15$$

For fiber B, we obtain

$$\bar{x} = (9.0 + 4.2)/2 = 13.2/2 = 6.60$$

The precise estimates of these means are 5.1 for fiber A, and 6.5 for fiber B.

For another example of finding the mean by this quick method, consider the chloride data in Table III. The third-largest observation is batch 2 (8.61); the third-smallest observation is batch 8 (7.81).

$$\bar{x} = (7.81 + 8.61)/2 = 16.42/2 = 8.21$$

The exact mean is 8.208.

These quick estimates of the mean are based on the assumption that the sample comes from a symmetrical distribution. If you suspect your distribution is highly skewed (e.g., incomes), the methods aren't appropriate. (Of coure, the mean may not be the appropriate measure of central value in such cases, either.)

Quick Estimate of Standard Deviation

Standard deviation is the measure of sample variability generally used by statisticians. It is useful because it permits valid comparison of the variability of different size samples. Other than statisticians, workers rarely use standard deviation because the textbook definition requires computing it by taking squares and sums of the observed values in the sample. Most people consider this too much work.

On the other hand, the range (the difference between the largest and smallest items in the sample) is an easily computed estimate of variability. Range, however, is a function of sample size so that direct comparison of the ranges of different size samples is not valid. For small samples (12 or less items) the range is almost proportional to the standard deviation times the square root of the sample size. This relation provides a very easy way to estimate the standard deviation of the sample.

Rules to Quickly Estimate Standard Deviation

1. For small samples ($N \leq 12$).

a. Obtain the sample range. W = (largest value − smallest value).

b. Divide the range W by the square root of the sample size. The quotient s is an estimate of the standard deviation of the sample,

$$s = W/\sqrt{N}$$

2. For large samples ($N \geq 12$).

a. Divide the sample randomly into m groups of equal size n, between 6 and 10. (Choose a size that keeps the number of excluded items less than 4.)

b. Obtain the sample range for each group W_i.

c. Take the sum of the ranges ΣW_i.

d. Divide the sum of the ranges by the number of groups m and the square root of the group size $\sqrt{n}$. The quotient s is an estimate of the standard deviation of the entire sample.

$$s = \Sigma W_i/m\sqrt{n}$$

To try an example, estimate the standard deviation of the batch chloride values in Table III. There are 10 observations so we use the small-sample estimate. The sample range is the largest item minus the smallest item, $W = 9.66 - 7.01 = 2.65$. Dividing the range by $\sqrt{10}$, we get $s = 2.65/\sqrt{10} = 0.84$.

This is an estimate of the standard deviation of the sample. Computation of the standard deviation of this same sample, using the most efficient technique, provides an estimate of 0.75, with 95% confidence limits of 0.51 and 1.33.

3 significance levels—Table IV

	10%	5%	1%
Outside count....	4	7	10
Corner count....	±9	±11	±13
Sign test.....	$\pm 1.6(N)^{1/2}$	$\pm 2(N)^{1/2}$	$\pm 2.6(N)^{1/2}$

For a further example of quick estimating of the standard deviation, find an estimate of standard deviation of the yield for the *B* line reactor shown in Table II. Since there are 48 items, we use the large-sample estimate. We divide the data into 6 groups of 8. Assuming the natural order of the data is sufficiently random, the ranges can be obtained as follows:

Group	Largest Observation	Smallest Observation	Range, W_i
1- 8	94.1	90.2	3.9
9-16	93.1	89.9	3.2
17-24	93.0	89.2	3.8
25-32	92.7	87.9	4.8
33-40	91.5	88.4	3.1
41-48	93.9	89.9	4.0
ΣW_i			22.8

The standard deviation estimated is $22.8/6\sqrt{8} = 1.53$.

Using the long computation, the precise estimate for standard deviation is 1.41, with 95% confidence limit of 1.17 and 1.80. Note that to obtain valid estimates, the data must be randomly grouped. If the grouping isn't random, and the data follows a trend, then the estimate will be too low.

Straight Line of Best Fit

When a correlation is believed to exist between two variables, as in the corner count example, we often ask: "What is the best straight line that describes the data?" The conventional estimate of this line is determined by use of the least-squares computation of the regression line. The computaton is closely related to the correlation computation mentioned above and is time-consuming and tedious. Without any arithmetic, the following quick method uses the median for a graphical estimate.

Rules for Line of Best Fit

1. Construct a scatter diagram of the data. (You probably have done this to apply the corner count test.)
2. Determine the over-all median point for the entire sample. (This is the intersection of the two median lines constructed for the corner test.)
3. Divide the data into three roughly equal groups. Allot any extra points of data to the middle.
4. Determine the median points of the two outside groups.
5. Construct a line one-third of the distance toward the over-all median, with its slope joining the median points of the end groups. (This is the estimate of the line of best fit.)

In Fig. 3, the line of best fit has been plotted for the corner count example of Figs. 1 and 2. The vertical lines indicate the grouping, and the centers of the small crosses indicate the median points of the end groups. In Fig. 3, the dashed line is the standard regression line determined by the long computation.

A Word in Closing

The nonparametric statistical methods discussed in this article aren't as efficient as the conventional methods for the case of data from the normal distribution. So much less time and effort is required to get the information that they do get, however, that they are efficient in a practical rather than in a statistical sense.

Statistical efficiency compares the amount of juice squeezed from a lemon with the amount of juice in the lemon. Practical efficiency compares the value of juice squeezed from a lemon with the cost of squeezing. In short, use these methods when time is dear and data are cheap.

The several quick, portable statistical methods described in this article require much less time to carry out than their standard counterparts. They are easy to remember and apply. Since they are nonparametric, they can be applied with relative safety to many problems. And because of these properties, they are well-suited for engineers to remember and use as rules-of-thumb for quick data evaluation.

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Meet the Author

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Educated at Harvard (A.B.) and the University of Illinois (M.S. in physics), Brown is a member of the Operations Research Society and the American Statistical Assn.

Engineer or business executive? That's a choice that nearly all enginers have to make, sometime during their careers. If you have considered the dilemma, you'll recognize that hard-nosed self-evaluation is required. An executive-recruiting consultant tells here how to do it.

Is Your Eye on the Executive Suite?

WILLIAM A. HERTAN, *Executive Manpower Corp.*

Chemical engineers in industry, like many other professionals, must eventually face a career decision that's not easily made. Should they continue as research or process engineers, or should they opt for managerial positions?

Benefits of either choice are considerable—providing that the decision has been reached by using the best of all career yardsticks: critical self-evaluation of goals, abilities and personalities. To help you in this self-analysis, we will set down here the broad qualifications and duties of an executive. You can judge whether you fit in, or whether engineering is still your goal.

Decisiveness and Leadership

The executive has to act with affirmation, even though all the facts can't be pulled together. Frequently, he is juggling such diverse factors as staff abilities, budget, priority of projects, multiple (and sometimes contradictory) pressures from superiors and colleagues, and possibility of success.

Whatever else he does, the executive must decide, then act and stick to it. As Bertrand Russell once said, no one can be sure of anything, but the good philosopher must act with conviction on what he believes is so. This holds true for the executive, too. But he not only must act with this authority; he must also bear responsibility and accountability for success or failure of the project.

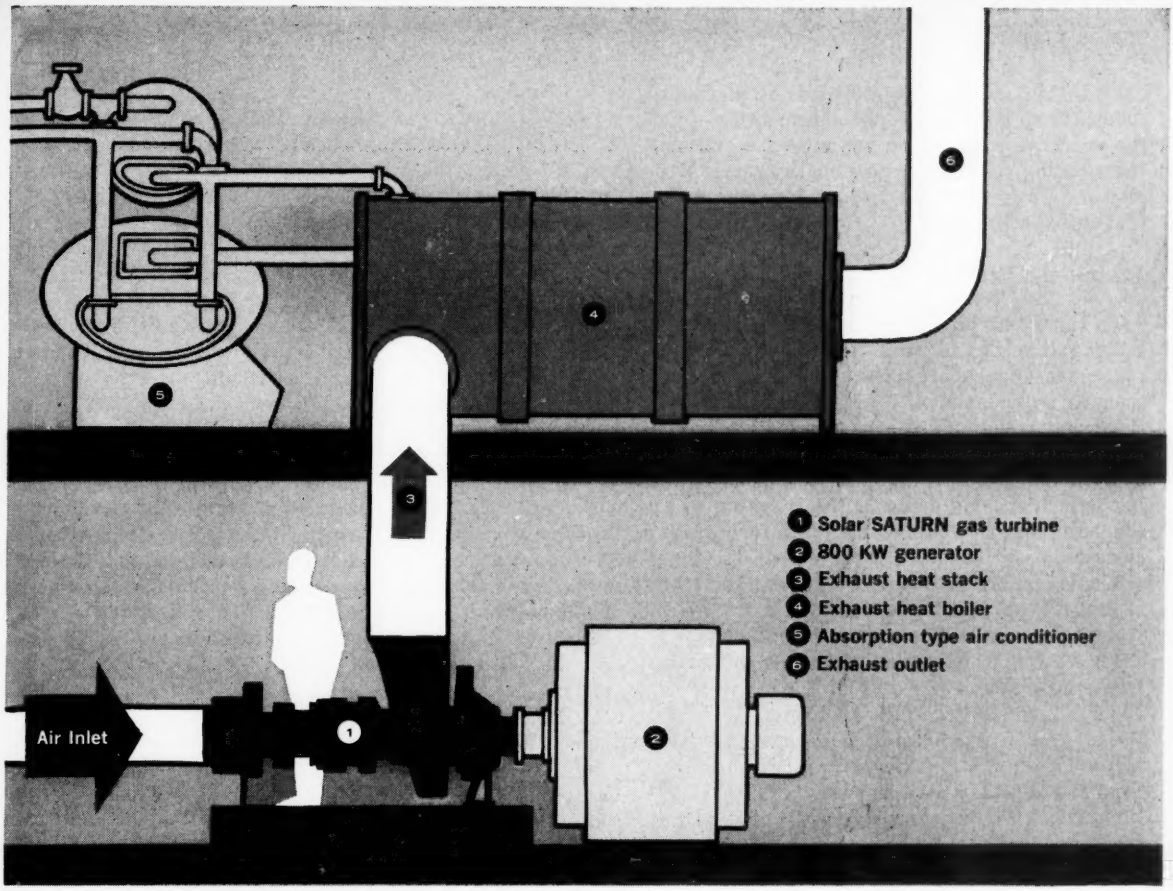
A chemical engineer, on the other hand, is by training and experience a professional who evaluates, tests and proceeds with technical caution to come up with the best solution. In a sense, his decision must be proved out through scientific analysis and synthesis. Short cuts are frowned upon.

Ask yourself, then, whether the challenge of making decisions in many-faceted situations, and frequently under pressure, overrides considerations of prudent engineering choices.

To meet the goals he sets up, the executive has to build a fire under his staff, get it to work enthusiastically. He assigns tasks to those who are on his staff and trusts their good judgment in action. Knowing the capabilities of each member of the staff, he delegates responsibility in proportion.

Often, though, the chemical engineer has to handle project details by himself, step-by-step. As a lone worker, or one of a project team, he may not have to communicate enthusiasm or inspire leadership. It follows that he may not have had to delegate authority to any great degree, and is unused to handing off details to subordinates.

Comparing the two roles, can you see yourself stepping out of that of the engineer to take charge of administrative and personnel details of a project? You



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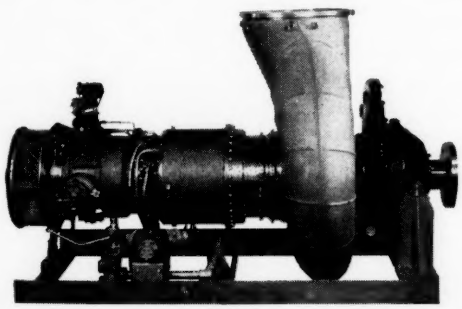

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have to "let go"—let the detailed, often fascinating, follow-through be handled by someone else—to assume the executive role. Would you miss the excitement of contributing your full professional measure to the success of a project, or would you prefer to run the team that does the job?

Taking the Broader View

To carry out his prime responsibilities, of course, the executive has to work closely with his superiors, colleagues and subordinates. He has to understand them as individuals, with personalities, talent, limitations and potentials of varying degree. Frequently, much of the executive's day is taken up with seeing people, talking with them on the telephone, corresponding with them. By doing so, he is trying to arrange the best possible "mix" of efforts for working efficiency.

Would you prefer to work with people, getting their best effort, or would you prefer as much isolation as possible to concentrate on the job at hand? A good example of a technical man who chose the former path is one we placed as director of R & D, at a salary of $35,000 plus stock options. Although he held only a B.S. degree, his genius for coordination of people and ideas made him a first-class administrator.

More often than not, the executive is a man of wide interests. He is probably active in professional societies, conferences, seminars and industrial trade association meetings. Interested in business problems within and outside his own industry, he finds out what's going on by studying magazines, reports and books.

Active socially, he also finds the time to concern himself with community affairs. The executive understands that in his position he must entertain business associates. Although this social load may be heavy, he appreciates its importance to himself and to his company.

One executive placed with a chemical company outdistanced his competitors for the position because, among other things, his chairmanship of a fund-raising drive proved he could tackle new situations and see them through to successful conclusions.

Here we have in mind the man who likes the success that comes from working with people of diverse views, and who enjoys the conferences that are part and parcel of his business and social life. Are you this man? Can you break up the flow of your work day or family life to solve with others a problem of mutual interest? Or do you prefer to stick to your specialty, do the job you know best, not be waylaid by other duties?

What Makes Managers Run?

Perhaps the single most important characteristic of the successful man—whether engineer, executive or salesman—is drive. The successful man always has a need to get to the top for personal reasons. Prestige, power, authority, money or a sense of accomplishment are all goals of that drive. Having a great measure of this drive, the executive also knows that many others have a need to climb to the top in their work.

Our files are full of examples of executives who have spent hours, weeks or a month extra to do a job just a little bit better, a bit more thoroughly. Many of us have this determination, many do not, but it can't be manufactured or taught. Competition for managerial positions gets keener as you move to the upper reaches of the executive level. Do you have enough drive to carry you as high as your aspirations?

It follows, of course, that the able executive has been successful most of his life. From childhood through schools and the university into his career, he has a history of challenges met and overcome. This has given him self-reliance that in turn contributes to his drive.

We usually look for the man who has been class valedictorian, an officer of a professional society, a committee chairman, or who has otherwise participated in organized activities. If you have this kind of background, chances are you will continue to seek new opportunities, new successes. If you haven't, your career pattern is more clear-cut, and you won't seek these extra challenges to fulfill it.

Looking to the Organization

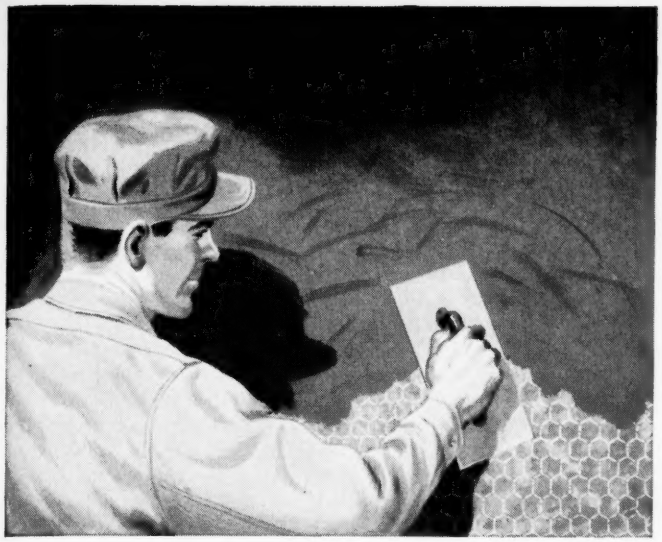
Interested in sales, production, research, marketing, advertising and profits, the executive is a man who can relate his departmental interest to that of the company as a whole. Though his primary job lies with his department, he doesn't underestimate the other activities of his firm, indeed derives satisfaction from a general success pattern in the company.

He can take his job home with him, too, and like to do it. Seeing himself with greater corporate duties in the near future, he also sees a pattern of personal success with the company that will call for the assumption of a broader business outlook. Do your ambitions fall into such long-range goals?

There are alternate routes to the top, of course; not all are through managerial echelons. The engineer of unique talent and abilities can often cut a niche for himself in the firm by working toward the position of consultant specialist or to a top spot in the R & D division.

In such positions, he is either assigned special projects or loaned out to various departments for temporary assignment. Frequently, the company uses his abilities as a consultant to its customers that have special problems. A corporation with a sufficiently large R & D group often makes great use of engineers and scientists of stature who have few administrative or personnel responsibilities.

Another route open to the chemical engineer who doesn't possess managerial ambitions is that of sales. Many prefer this type of give-and-take people-to-people activity that puts them in personal contact with customers. Top sales positions pay well. And many firms put their best salesmen (not managers) on "national accounts"—those corporate customers that buy continually in volume, year after year. The persuasive chemical engineer, by combining his natural



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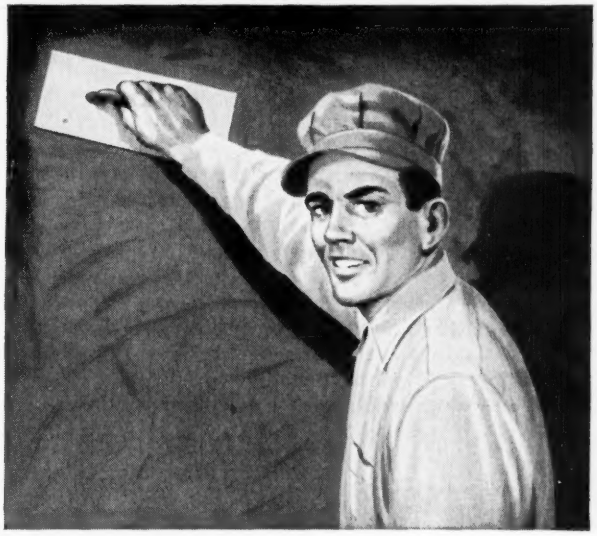

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sales skill with his technical background, can find fine opportunities also as branch or territorial sales manager (see *Chem. Eng.*, May 15, p. 178).

Making an Important Choice

To get ahead—whatever your direction of ambition as a chemical engineer—you can do two things: increase your knowledge and increase your reputation.

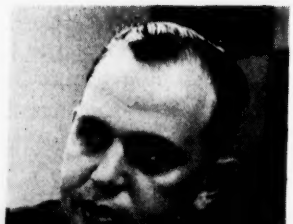
For the first, you should continue to pursue your education long after you leave your undergraduate preparation. This may mean pursuit of formal studies to advanced degrees, but it also means study that broadens your educational base or increases your knowledge and awareness of a particular field.

A consistent output of technical papers and activity in professional societies enhances your external reputation, helps to give others within the industry a beter idea of your abilities. But an internal reputation is equally important. Your associates and superiors play key roles in promotional recommendations. The man who proves himself a cooperative and willing associate creates a good, solid internal reputation.

Though of a general nature, these remarks on a profile of the business executive are based on our experience in recruiting such a man for major industrial corporations. We believe that it's a representative portrayal of the managerial man, showing both the challenges and demands of the executive position. Rewards—money, power and prestige—are obvious. Because it does give you some idea of what is demanded of the working executive, there's only one more question to ask of yourself in this self-analysis:

Does the executive role, rather than your engineering role, appeal? It's your decision.

Meet the Author



WILLIAM A. HERTAN *is president of his executive recruiting firm. He holds a B.S. degree in industrial relations and personnel management from New York University. Prior to founding his New York City firm in 1956, he was with Harper Associates, which he also cofounded. Author of many articles on management recruitment, Hertan coedited a major section of Prentice-Hall's "Personnel Policies and Practices Report." A Navy combat officer during World War II, he later served as personnel officer of the amphibious training command. He is a member of the Wall Street Lions Club and the Newcomen Society.*

Ch.E. WRITERS BEWARE: PENALTY FOR HUMOR IS READER INTEREST

Few trends escape the notice of businesspaper editors or chemical engineers engaged in their work. A trend recently evident is a growing archness on the part of chemical engineer-writers.

R. Byron Bird, and his cohorts at Wisconsin, last year published a well-accepted textbook on one of the "in" subjects of chemical engineering—transport phenomena. In the preface of their work, these authors got off to a lead in the race of acronymy, sarcasm, one-up-manship and conceits that increasingly appear under bylines of chemical engineers. Get a copy of their book. You will find that putting together first letters of each sentence of the preface dedicates it, O. A. Hougen being the recipient.

Upon delving into another book that was last month delivered to my desk—R. Aris' "Optimal Design of Chemical Reactors"—I found the professor was one up on his Wisconsin neighbors. The Minnesota Ch.E. touts S. Potter, for example, in citing "heat of mixing" arguments that inevitably arise when chemical technologists gather. Depending on one's viewpoint, one can be either for or against the heat of mixing. Unless you are slow on the uptake in the midst of a technical discussion, the gambit works either way.

Found in off-the-cuff remarks of puckish chemical engineers are some well-phrased conceits, too. Rarely do they reach print, but one notable exception was last year's distillation symposium in Britain. Gist of one discussion about content of session's papers was dutifully noted by the recorder in the following statement:

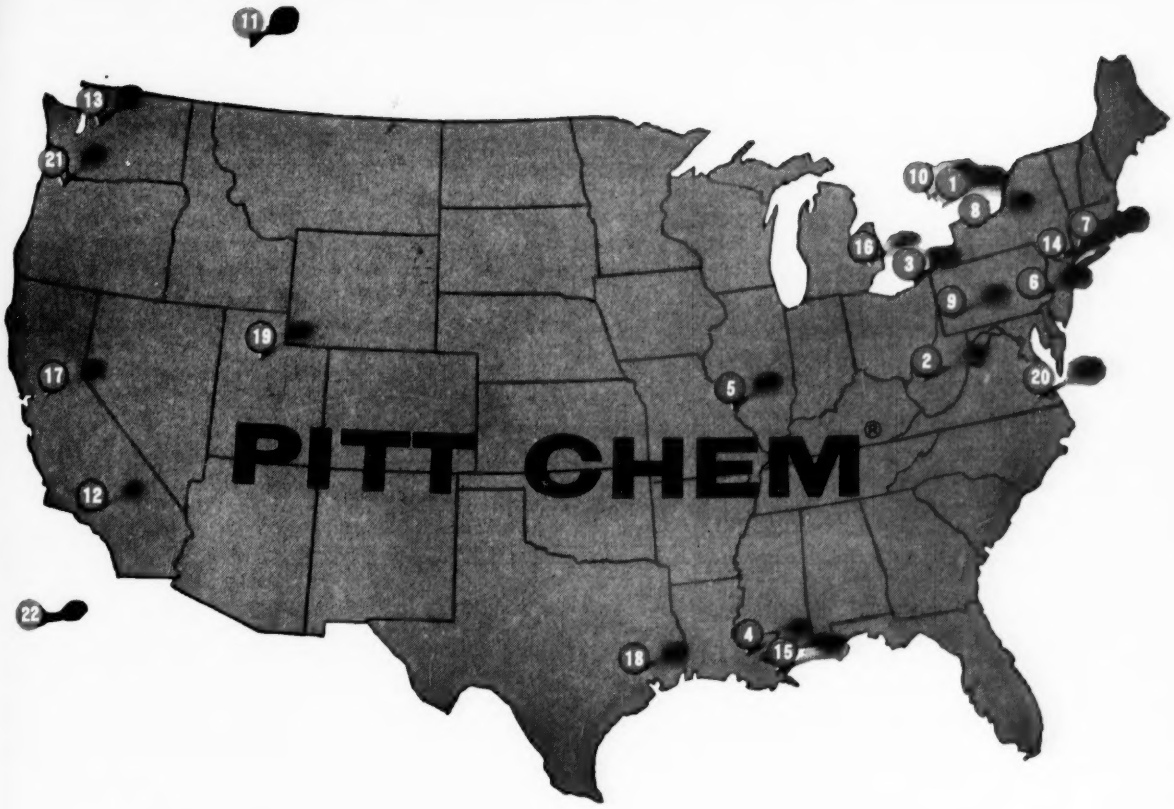
"In these papers, there is a hidden factor, called the Bikini factor—the ratio of the interesting subjects revealed to the essentials which were concealed. There is an interesting correlation, doubtless, between the technical and commercial parameters."

The moral of all this is hidden, too, somewhere. If you got this far, you may as well look for it.

GERMAN DEPLORES Ch.E. SHORTAGE

At a recent congress of the German Bunsen Society, a noted West German industrialist viewed with alarm the shortage of chemical engineers in his country. Paul Baumann, chairman of the board of Chemische Werke Huels, pointed out that the growing gap between supply and demand has led to a current shortage of 1,500 chemical engineers.

The universities alone, said Prof. Baumann, need 500 Ph.D. chemical engineers, industry another 300 by 1963. To alleviate the shortage, he suggested a reduction of university training from current nine years to a 6-7 year course of instruction.



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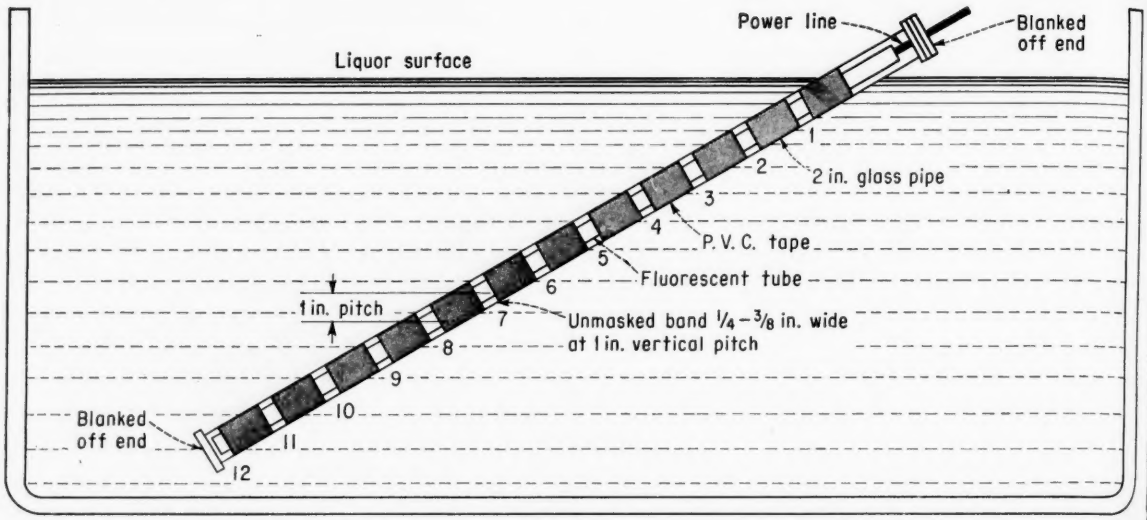

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E. F. SYMONS

Radium Hill Project, Port Pirie, South Australia

This simply constructed device gives a quick and reliable indication of the turbidity of supernatant liquor in a thickener or any other constant-level tank.

The device is constructed from a length of 2-in. diameter glass pipe wrapped with P.V.C. tape so as to leave $\frac{1}{4}$ to $\frac{3}{8}$-in. unmasked bands at any selected uniform pitch. A standard fluorescent lighting tube is placed in the pipe, the ends are sealed and the unit is immersed in the liquor at a selected angle, as shown.

The number of the deepest visible light band indicates the turbidity (or clarity) of the liquor. The upper surface of the tube is cleaned as necessary with a nylon bristle broom.

The unit we installed at our plant has proved to be a valuable production aid, particularly in the elimination of argument among production personnel over the turbidity of thickener supernatant liquors.

DESIGN PUMP AIR CHAMBERS TO CONTROL PRESSURE PULSATION

CARL JAHREIS

T. Shriver & Co., Inc., Harrison, N. J.

The pulsating pressure characteristics of reciprocating pumps are familiar to most operating engineers. There are two common methods for overcoming this problem: (1) use a duplex, triplex or other multiplex pump or, (2) place an air chamber in the discharge line.

An operating engineer will generally choose the latter method because the air chamber can be added to an existing pump after installation. The problem becomes, therefore, "What size air chamber must be added so that the pulsations will not exceed a given range?" The same basic analysis and solution can be applied to all types of reciprocating pumps.

Here, for example, is an analysis of the pulsation of the common plunger-type reciprocating pump, where the length L is considerably greater than R, see Fig. 1.

The instantaneous flow from the pump is given by

COMING OCTOBER 2

Easy-to-Build Metering Pump Handles Corrosives

By G. MacBeth and C. H. Raddle, July Contest Winners

***How Readers Can Win**

$50 Prize for a Good Idea—Until further notice, the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for publication in the Plant Notebook. Each period's winner will be announced in the second following issue and published in the fourth following.

$100 Annual Prize—At the end of each year, the period winners will be rejudged by the editors and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant Notebook Editor, *Chemical Engineering*, 330 W. 42 St., New York 36.

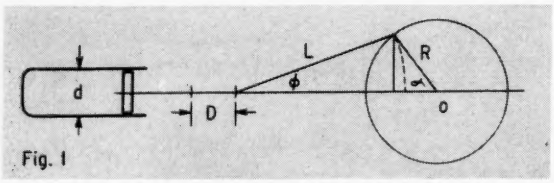


Fig. 1

$$C_i = \frac{\pi d^2}{4} R \sin \alpha \qquad (1)$$

For a simplex pump, this results in a flow as shown in Fig. 2a, and for a duplex pump, as in Fig. 2b.

The resulting pressure pulsations can be expressed as a power function of C_i with the exponent dependent upon the hydraulic conditions prevailing within the system. While the basic problem, control of pressure fluctuations, is the same for both the pump designer and the operating engineer, the solution can be quite simpler for the operating engineer.

Let us examine the duplex pump. In actual practice, the idealized curve of Fig. 2b will be modified to show a cutoff, as illustrated by Fig. 3. Values of α must be determined in relation to the pump efficiency. The dotted line represents the average flow.

This sinusoidal-type curve also applies in general to hydraulically actuated diaphragm pumps.

At the start of the pumping stroke, the instantaneous capacity of the pump is less than the average capacity. Air compressed in the air chamber by the previous stroke forces liquid from the chamber to supplement the flow of the pump.

As the stroke continues, the pump capacity first equals and then exceeds the average capacity. It continues to exceed the average capacity until it reaches a maximum at the midpoint of the stroke, and then gradually decreases until it again equals the average. During the latter portion of the stroke, the excess is stored in the air chamber, recompressing the air.

This stored volume is represented by the clear areas of Fig. 3.

Applying the gas laws to the volume change, we have

$$V_1 = V_0(14.7/P_{min}) \qquad (2)$$

Test Your CEQ

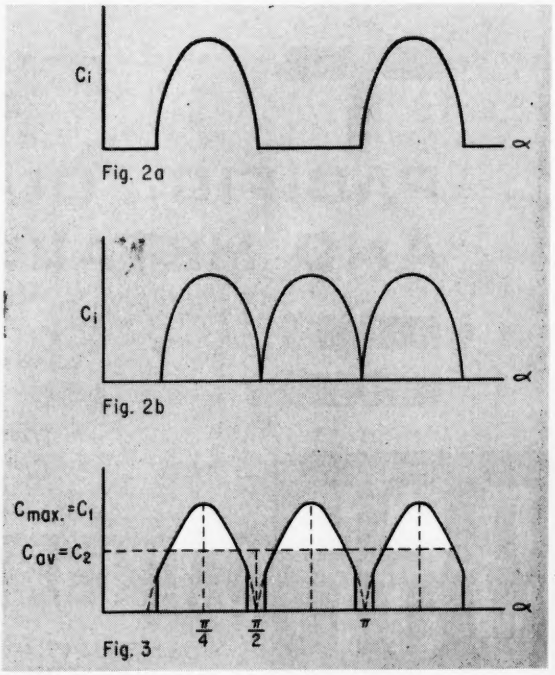
ROBERT LEMLICH

Here's a switch. I'll state the solution and you devise the problem!

▶**Solution:** After the first transfer, we have, in the second vat, a concentration of A equal to $q/(V + q)$ and a concentration of B equal to $V/(V + q)$.

After the second transfer, we have, in the first vat, a concentration of B equal to $(q/V) \times V/(V + q)$ or simply $q/(V + q)$. Thus, at the conclusion of the second transfer, the concentration of A in the second vat equals the concentration of B in the first vat.

Answer on page 154



$$V_2 = V_0(14.7/P_{max}) \qquad (3)$$

$$\Delta V = 14.7 V_0 \frac{\Delta P}{P_{min} P_{max}} \qquad (4)$$

where V_0 is the volume of the air chamber; V_1 is the volume of air at P_{min}; V_2 is the volume of air at P_{max}; P_{min} is the minimum absolute pressure during the pumping cycle; P_{max} is the maximum absolute pressure during the cycle; ΔP is equal to $P_{max} - P_{min}$.

Although solution of Eq. (4) by the pump designer requires integration of the capacity curve, the problem is much simplified for the operating man. First, he is faced with an existing pump in service that is exhibiting excessive pulsation. What additional air-chamber volume must be used to reduce the pulsation to within a specified range?

▶**Example:** A pump on a given service shows a maximum pulsation of 70 to 100 psig. What size air chamber would be required to hold the pulsations to within 82.5 to 87.5 psig.?

From Eq. (4) we have

$$\Delta V = 14.7 V_0 \frac{30}{84.7 \times 114.7}$$

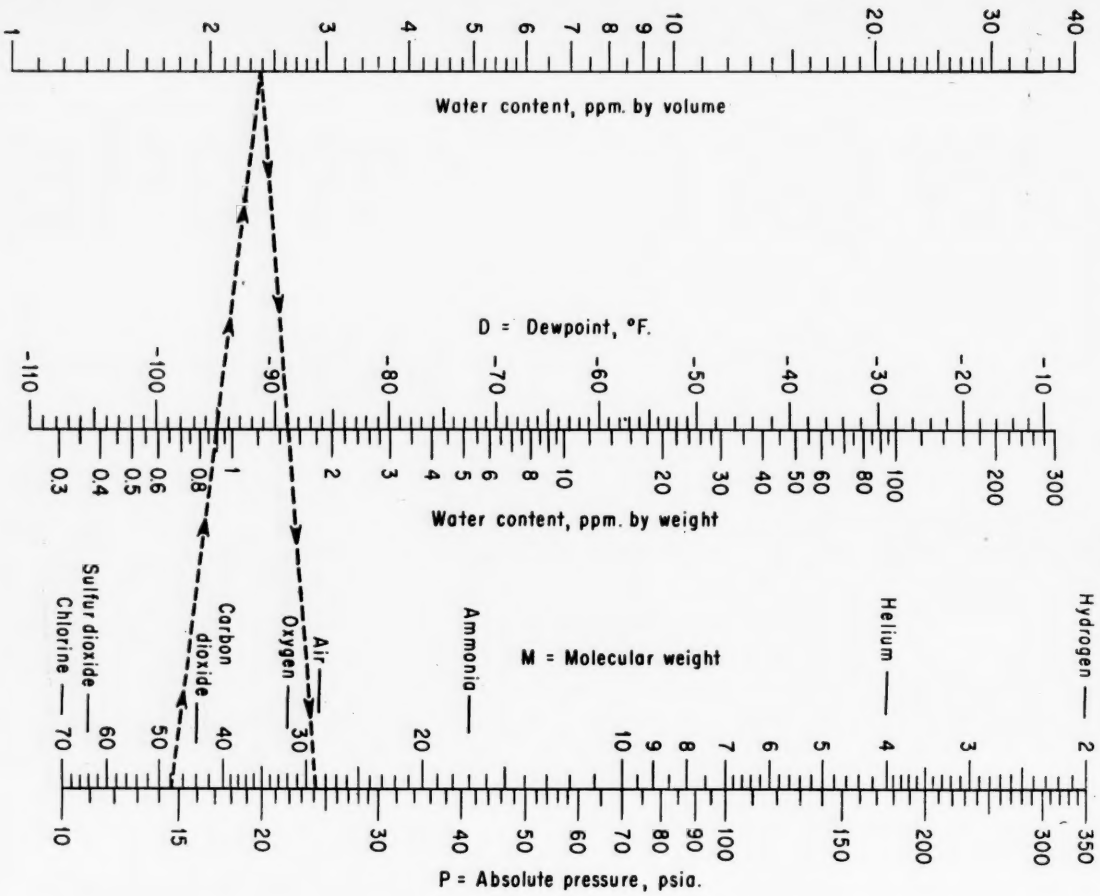
$$= 0.0455 V_0$$

For a pulsation of 5 psi. we have

$$0.0455 V_0 = 14.7 V_0' \frac{5}{97.2 \times 102.2}$$

$$V_0'/V_0 = 6.15$$

Therefore, a total air chamber volume of 6.15 times the original volume will be required to hold the pulsations within a 5-psig. range. The original chamber volume can be obtained from physical measurement.



NOMOGRAPH CONVERTS DEW POINT TO WATER CONTENT OF GAS

FRANK CAPLAN
Kaiser Engineers, Oakland, Calif.

The dew point of a gas is a convenient measure of its moisture content. It is defined as the temperature to which the mixture of gas and water vapor must be cooled to just produce saturation, i.e., the gas is in equilibrium with liquid water or ice.

At most engineering pressures and temperatures and at the low concentrations existing in gases, water vapor behaves like a perfect gas. It follows from Avogadro's principle and Dalton's law of partial pressures that, for a mixture of perfect gases, volume % = pressure % = mole %.

Therefore, if P_s is the saturation vapor pressure of water or ice, P the total pressure of the mixture and M' the average molecular weight of the mixture, then

$$\frac{P_s}{P} = \frac{\text{moles water}}{\text{moles mixture}} = \frac{18 \text{ lb. water/mole of water}}{M' \text{ lb. mixture/mole of mixture}} \quad (1)$$

Modern dryers produce such low dew points that the molecular weight of the mixture can be taken as the molecular weight of the gas, M.

Therefore, the water content of the gas in ppm. is

$$\text{by volume} = 10^6 P_s/P \quad (2)$$

and the water content in ppm. by weight is

$$18 \times 10^6 P_s/PM \quad (3)$$

The nomograph is a graphical solution of Eqs. (2) and (3) except that saturation temperatures (dew points) and have substituted for vapor pressure.

► **Example:** Air at 14.7 psia. has a dew point of −95 F. What is water content by volume and by weight?

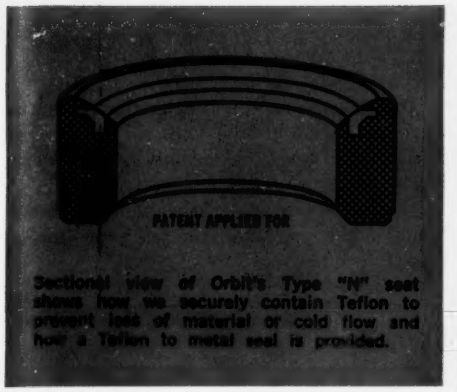
Align $P = 14.7$ with $D = -95$ and read 2.38 ppm. by volume. Align with $M = 29$ and read 1.47 ppm.

---------Answer to Test Your CEQ---------

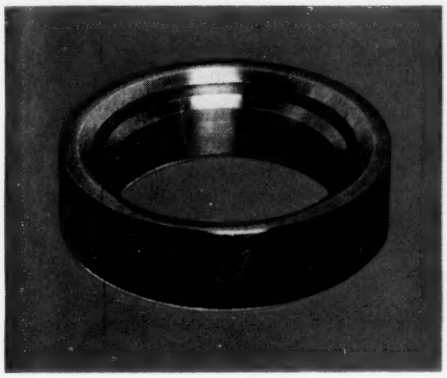
The problem is really a variation on an old classic that goes back many years and has appeared in one form or another in many places. I don't know the original author.

► **Problem:** One vat contains a liquid *A* and a second contains an equal volume of liquid *B*. A brimming bucketful of liquid from the first vat is transferred to the second and the resulting mixture stirred thoroughly.

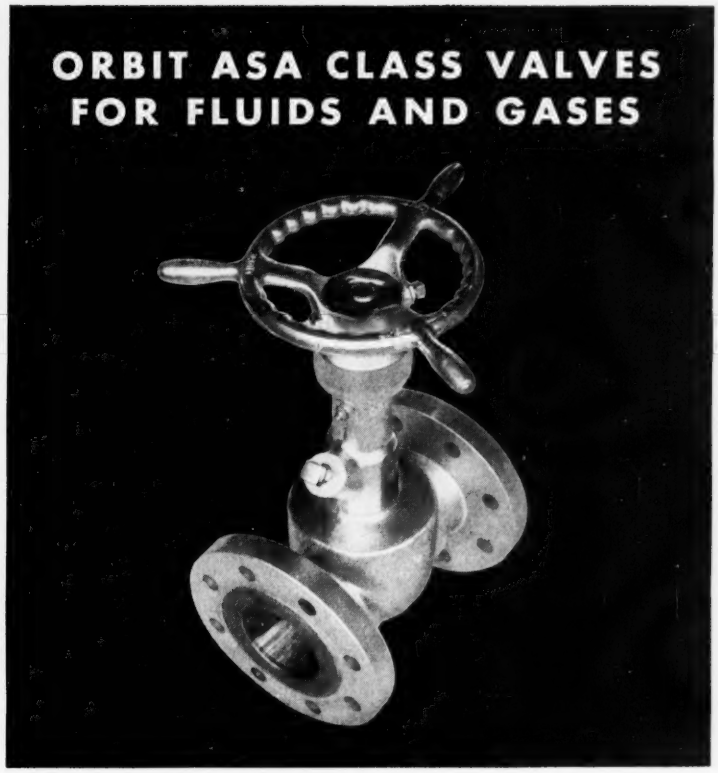
Then, an equal-sized bucketful is transferred from the second vat to the first and stirred. If the liquid volumes are additive, is the concentration (by volume) of *A* in the second vat greater than, equal to or less than the concentration of *B* in the first vat?



Sectional view of Orbit's Type "N" seat shows how we securely contain Teflon to prevent loss of material or cold flow and how a Teflon to metal seal is provided.



ORBIT ASA CLASS VALVES FOR FLUIDS AND GASES



ORBIT COMBINES THE THREE BEST KNOWN SEATING PRINCIPLES IN ONE VALVE SEAT

ORBIT TYPE "N" BODY SEAT WITH MOLDED TEFLON* FEP RESIN PROVIDES:

(1) resilient seating with metal-to-metal back-up

(2) friction-free seating

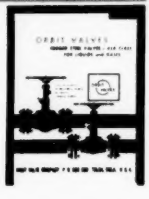
(3) seating without lubrication

TYPE "N" BODY SEAT HAS 400° Fahr. MAXIMUM TEMPERATURE RATING.

The convex seating surface formed by the Teflon and metal provides for absolute shut-off and assures immediate contact for positive closure. The Teflon is so contained that it is not affected by high differential pressures flowing across the seat. Normal manufacturing tolerances as well as normal valve wear are compensated for by the resilient Teflon material. Solid particles, such as line scale, dryer dust, catalyst carry over, etc. do not prevent the Orbit Valve from seating properly. Orbit's Type "N" seat provides both metal-to-metal and Teflon sealing. The metal-to-metal seat, provided by tapered metal edges, is additional assurance that seating surfaces will not be lost in case of disaster by fire. Heat treated metal seat retainer holding Teflon provides durable working surfaces.

*Teflon is duPont's registered trademark for its family of fluorocarbon resins, including FEP resin.

FOR ADDITIONAL INFORMATION WRITE FOR OUR NEW CATALOG 61-B



ORBIT VALVE COMPANY
P. O. Box 699 Tulsa, Oklahoma
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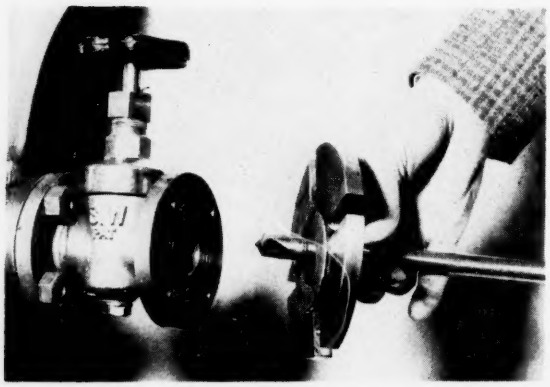
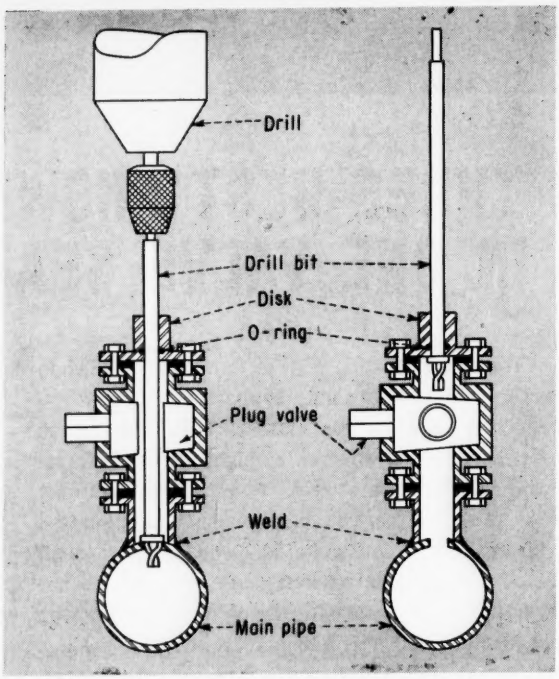
ORBIT VALVES

MAKE YOUR OWN TOOL FOR TAPPING PRESSURIZED LINES

EINAR WIKSTROM
AB Kabi, Stockholm, Sweden



Tool is attached to plug or gate valve on main pipe.



Gaskets and O-ring prevent pressure loss from main pipe.

I have designed a tool for making connections to pipes under pressure. The device consists of a drill bit, an O-ring and a slotted disk, suitable for connection to various sized flanged valves.

The procedure for making the connection is as follows:

1. Weld a short length of pipe with a flange to the main pipe.

2. Connect a valve to this flange. This can be either a gate valve (photo) or a plug valve (sketch).

3. Connect the tool to the valve, open the valve and drill a hole through the main pipe wall.

4. Pull back the drill bit, close the valves and remove the tool from the valve.

Now there is pressure behind the valve and we are ready to install a gage, a small branch pipe line or some other tie in.

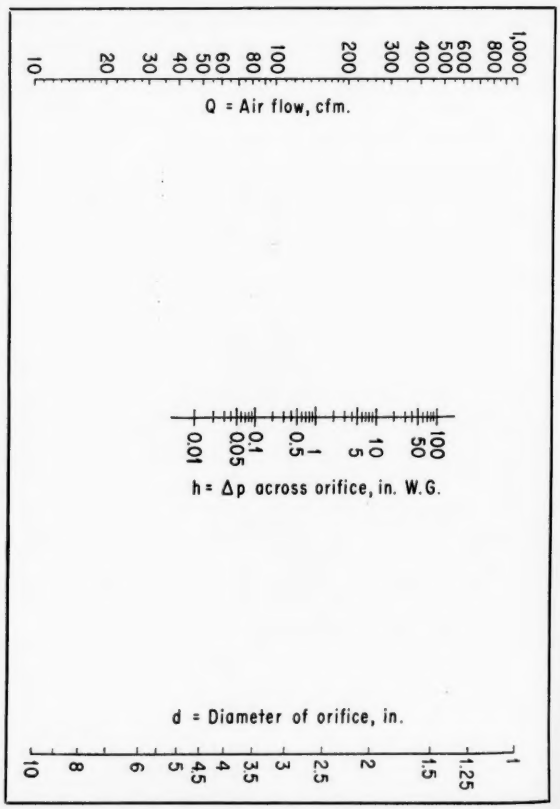
AIR FLOW THROUGH THIN-PLATE ORIFICE

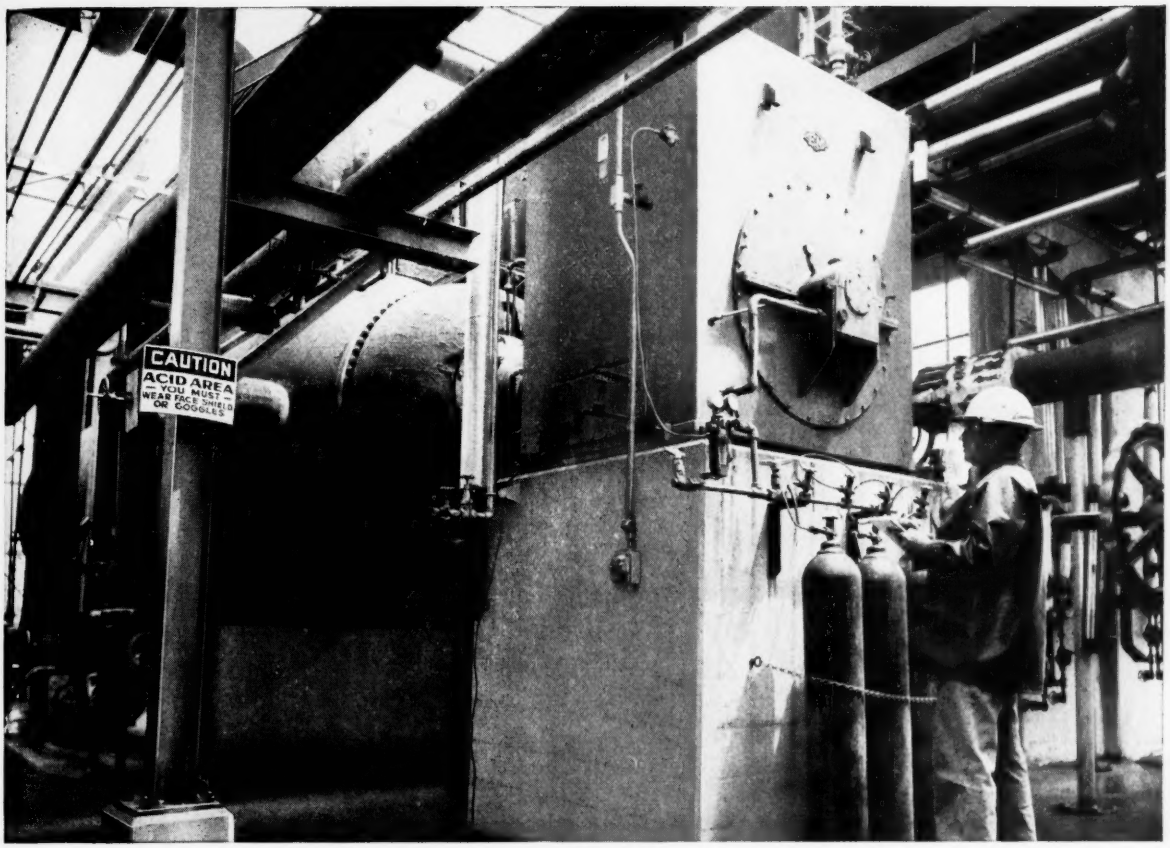
EDWARD J. GIBBONS
Colgate-Palmolive Co., Jersey City, N. J.

This chart gives the theoretical air flow through a thin-plate orifice if the downstream pressure is less than critical. The chart solves the following familiar equation $Q = 21.8d^2\sqrt{h}$ where Q is the air flow, cfm.; d is the orifice diameter, in.; h is the pressure drop across the orifice, in. water gage.

To obtain the actual air-flow value, Q must be multiplied by the coefficient of discharge for the orifice in question.

Air conditions: 100 F. and 14.7 psia.





E-M TEIGF 400 hp, 585 rpm, 4600 v Squirrel-Cage Induction Motor driving contactor at Aurora Gasoline Company's Detroit refinery.

E-M's TEIGF Motor Provides Built-in Protection in Hazardous Area

"Protection for safe, reliable operation in an atmosphere of olefinic hydrocarbons and corrosive sulfuric acid."

This was the prime feature which prompted petroleum engineers at Aurora Gasoline Company to choose an E-M TEIGF (Totally-Enclosed Inert-Gas Filled) Custom-Tailored Motor to drive a large contactor at their Detroit refinery's new alkylation plant.

Here's how this built-in protection is assured in E-M's TEIGF Motor:

A low but positive pressure within the motor enclosure keeps dangerous, harmful gases out. Inert gas (nitrogen) pressure is maintained inside the enclosure at 1 to 2 inches of water above atmospheric . . . thus the motor always operates in a harmless atmosphere all its own, unaffected by ambient conditions. This means protection against the possible twin dangers of explosion and internal corrosion.

The E-M TEIGF Motor provides protection against expensive operation, too. Gas loss is lower than commercial standards. Special oil-pressure gas seals provide positive seal at shaft bearings. Seals are virtually non-wearing.

Motor maintenance is minimum . . . the motor in the photo above operates 24 hours per day, with a scheduled maintenance shutdown only once every twelve months.

Built-in protection, economical operation, minimum maintenance . . . it all adds up to an outstanding motor drive for this hazardous area.

Learn more about E-M TEIGF Motors now. Our application specialists will tailor a unit to fill *your* specific needs. Contact your nearest E-M Sales Engineer for TEIGF Motor Bulletin No. 226, or write to Electric Machinery Mfg. Company, Minneapolis 13, Minnesota.

Specialists in making motors do exactly what you want them to

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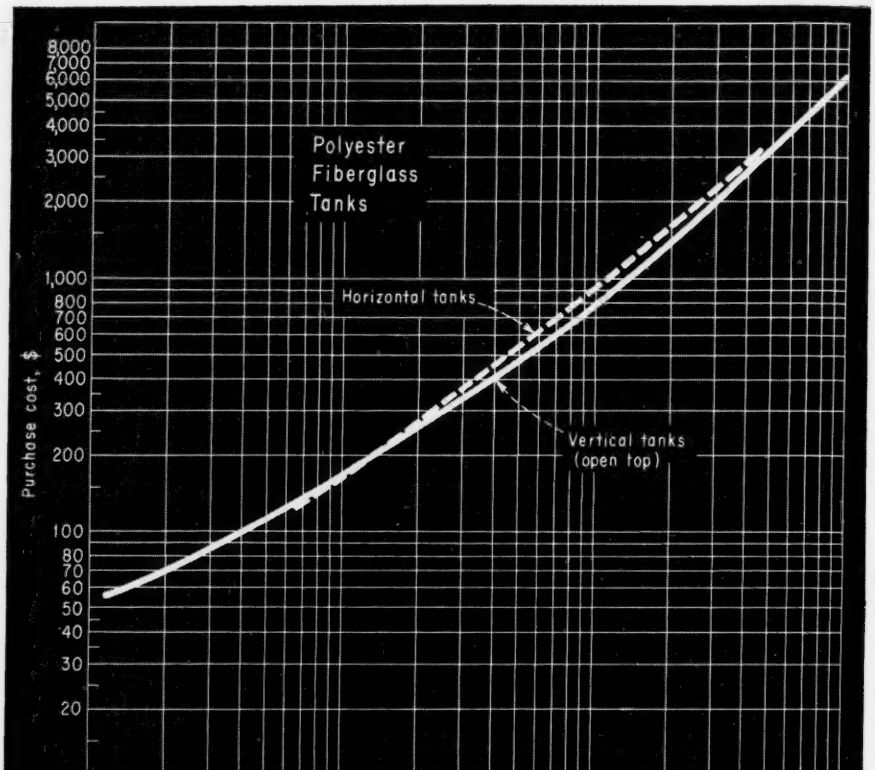


No. 56: Polyester-Fiberglass Tanks

GEORGE C. KRUSEN, II, *Asst. to Vice President, R&D, Dewey and Almy Div. of W. R. Grace, Cambridge, Mass.*

Plastic storage tanks are not normally stocked by manufacturers but are built to order, on a quick delivery schedule. Purchase costs of polyester-fiberglass "standard" storage tanks are given by the curves. Costs of horizontal tanks do not include mounting saddles that are usually supplied by the purchaser. All cost data are based on usual mat-construction techniques and use of general-purpose polyesters. Costs refer to June 1960.

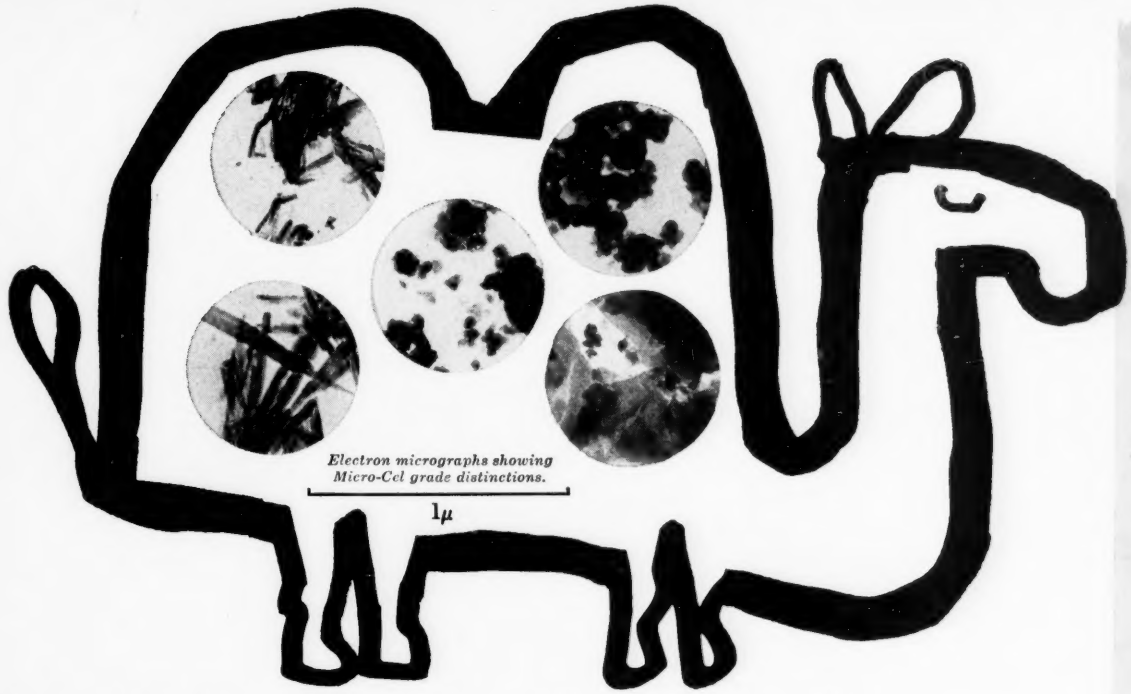
Tanks can be supplied with a variety of extras, such as flat covers or domed tops for manholes. See Table I. Table II includes data on flanged outlets and PVC fittings.

Cost of polyester-fiberglass flat covers and domed tops—Table I

	Tank Diameter, Ft.					
	1	2	3	4	5	6
Flat covers, $	25	45	120	195	285	—
Domed top with manhole, $	—	30	80	120	160	240

Cost of flanged and threaded fittings—Table II

	Outlet Bore, In.								
	1/2	3/4	1	1-1/4	1-1/2	2	3	4	6
Cast, reinforced-plastic nozzle flange, $	—	16	16	16	17	17	21	23	30
Same as above but located on side of tank, $	—	20	20	20	20	21	25	30	37
PVC threaded fittings for standard pipe thread, $	4	4	12	12	12	15	—	—	—



Electron micrographs showing Micro-Cel grade distinctions.

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Micro-Cel®, Johns-Manville's new line of synthetic calcium silicates, absorbs up to 6 times its weight in water . . . remains a free-flowing powder after absorbing triple its weight in liquid. 4½ lbs. bulk to a full cu. ft. Costs only 7 to 8¢ a lb. (F.O.B.). Surface areas up to 175 sq. m/gr. Micro-Cel, available in several grades and offering a wide range of physical properties, may provide the cost-cutting answer to your formulating problems. For further information, samples and assistance, mail in coupon!

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☐ Please send free sample of suitable grade of Micro-Cel for use in:_____

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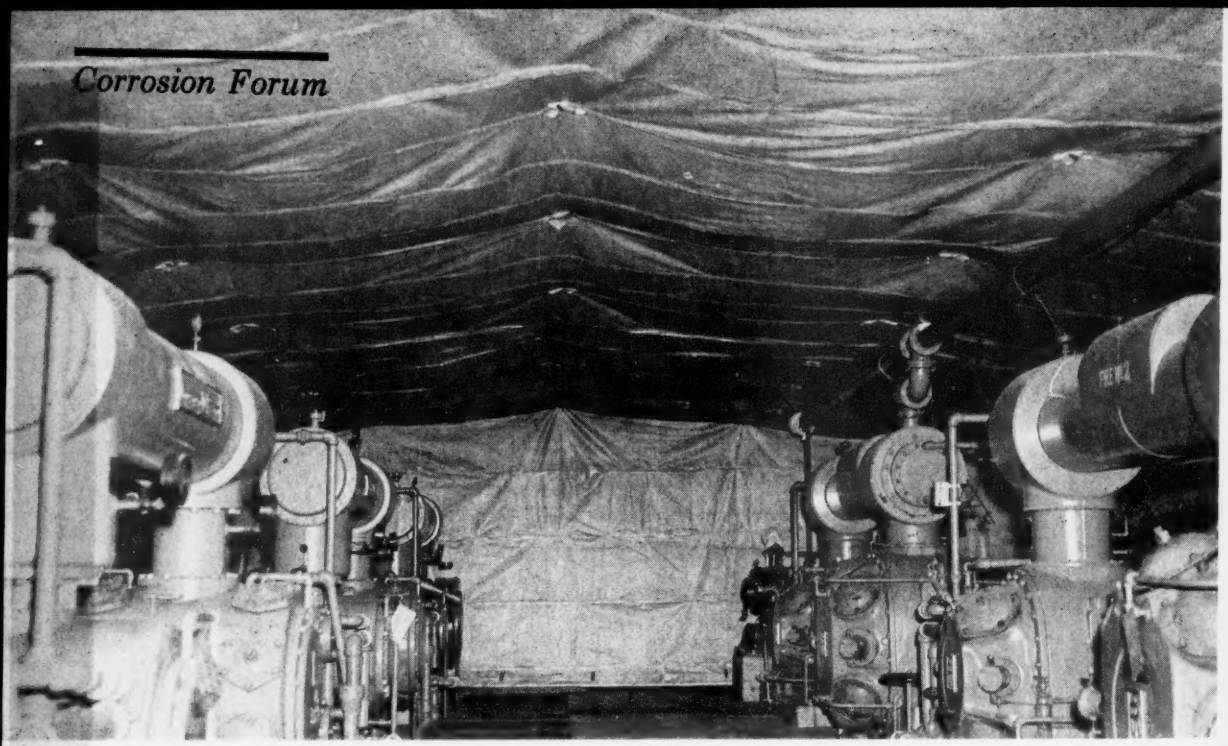
City_____ Zone____ County_____ State____



Interior of hutment. Roof is suspended from cables strung above enclosure.

Cheap Way to "Mothball" Equipment

Easily and cheaply erected, these hutments of burlap, double-coated with polyethylene, provide low-humidity areas for dead storage of unused equipment.

Hutments constructed of polyethylene-coated burlap provide effective and low-cost protection against corrosion caused by humidity. Small dehumidifying units are sufficient to maintain the low moisture levels required for protection against rust and other moisture-induced corrosion.

Developed for the Army Ordnance Corps in Louisiana, to protect unused military equipment, the idea is easily adaptable for use in dead storage of industrial equipment, particularly in high humidity areas.

The hutments were developed by the Hardin Bag & Burlap Co., New Orleans, and feature walls and ceilings made of 10-oz. burlap, extrusion coated on each side with a 4-mil film of polyethylene. The burlap, used in 40-in. widths, reinforces the polyethylene, making it possible to sew strong seams between the widths, and eliminating the need for a framework support. While the burlap supplies strength to the laminate, the polyethylene plastic provides an excellent water-vapor-transmission barrier. Coating both sides of the burlap precludes the danger of pinholes. The polyethylene used in this application was made by Eastman Chemical Products, Inc. (an Eastman Kodak subsidiary), and the extrusion coating of the burlap was performed by Ludlow Plastics, Homer, La.

▶ **Erection**—Assembly of the hutments is performed with considerable ease. Hooks, fastened to the plastic-coated burlap during prefabrication, are slipped over steel cables installed over the area to be enclosed. The coated sheet is pulled taut by auxiliary cables. The sides, or walls, of the hutment are fastened to the floor by two-by-fours embedded in mastic and secured to the floor. A wooden plate, attached to the two-by-four, clamps the coated sheet in place.

▶ **Installations**—The first hutment, erected at the Shreveport, La., Ordnance Plant, is 220-ft. long, 40-ft. wide and 14-ft. high at the peak, with 11-ft. walls. Zipper doors, which open to 12 × 10 ft. provide ample clearance for bulky pieces of equipment.

This storage system was so effective and economical that 14 more hutments were added to the Louisiana Ordnance installation.

Another was erected at the Holston Ordnance Works, Kingsport, Tenn. The Holston facility measures 109 × 59 × 14 ft.

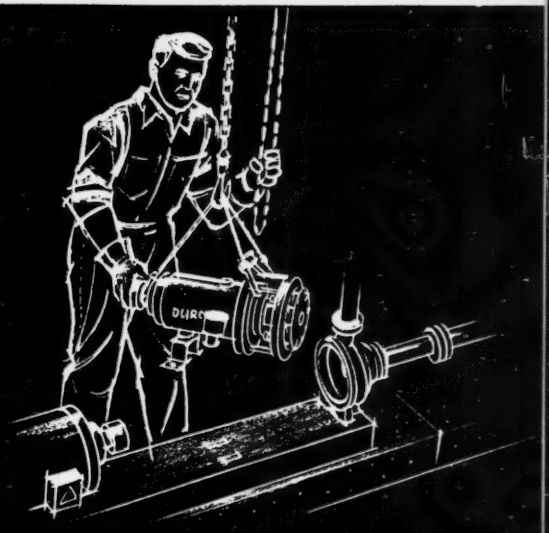
▶ **Dehumidification**—Moisture level in the hutments is maintained at a low level by standard dehumidifying units. Since only the area occupied by the stored equipment requires dehumidification, the main-

specific design for low cost maintenance

DURIMET
DURICHLOR
CHLORIMET 2
CHLORIMET 3
DURCON
DURCO D-10
DURIRON
18-8-S
18-8-S-Mo
DUCTILE IRON
MONEL
INCONEL
NI-RESIST
NICKEL
TITANIUM

Fourteen alloys for any corrosive service

Interchangeable parts: 1 bearing housing + 1 shaft = 10 pumps



One man—one craft to remove all rotating parts

Is pump "down-time" increasing your operating expense?

Why disconnect motors and process piping when making pump repairs? The Durco Series "H" pump is designed for complete servicing by one craft to speed maintenance and cut costs.

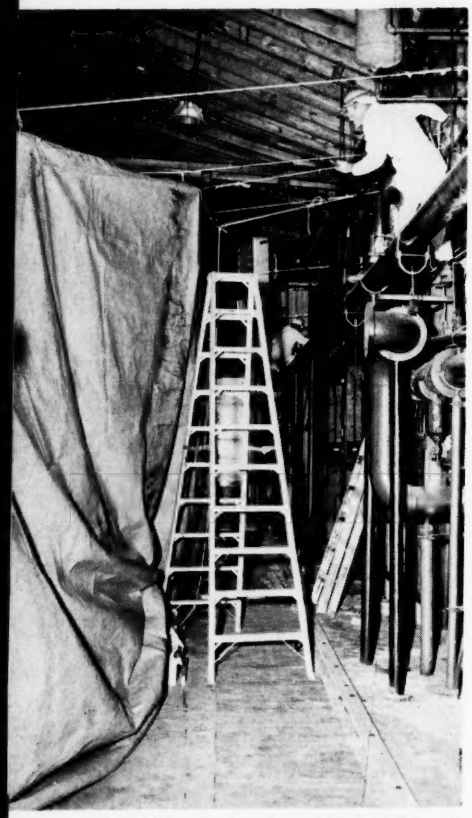
Why inventory a multitude of bearing, housing, shaft and seal sizes? One set of these is interchangeable on Durco "H" pumps with capacities from 10 to 750 GPM and TDH from 10 to 350 ft.

Why be "short changed" on corrosion resistance? Durco leads in the development and manufacture of corrosion resistant alloys. Castings are designed for optimum corrosion resistance and hydraulic efficiency and are produced in our own foundry to assure complete quality control from raw material to finished pump.

Why settle for less than Durco? Durcopump's hydraulic efficiency combined with the right alloy and rugged, heavy duty bearing and shaft design provide long life and low operating cost.

THE DURIRON COMPANY INC., *Dayton, Ohio / Serves the process industries*

DURCO



Auxiliary cables, here being tightened by workmen, pull roof-sheet taut. Main cables support roof structure.

tenance of low relative humidity under the hutment is both less expensive and more effective than similar controls covering total shed areas.

Even after the hutment is installed, alterations in its size can be made by moving the walls, which fold into accordion pleats.

▶ **Operating for Three Years**—The value of this unique storage method has been proved at the Shreveport plant, where the storage system has been used for over three years. Treated with nothing more than a light coating of oil before storing, equipment such as compressors, motors, lathes, gages, scales and other machinery with precision surfaces has withstood rust and corrosion. And this in Louisiana, with its high humidity and temperatures that may rise to 105 F.

Epoxy Repairs Drums That Spring Leaks in Transit

A leaking metal drum is always a problem, but a drum that starts leaking while in transit is a real headache for the carrier. One trucker has found an epoxy compound to be an effective means for making quick repairs.

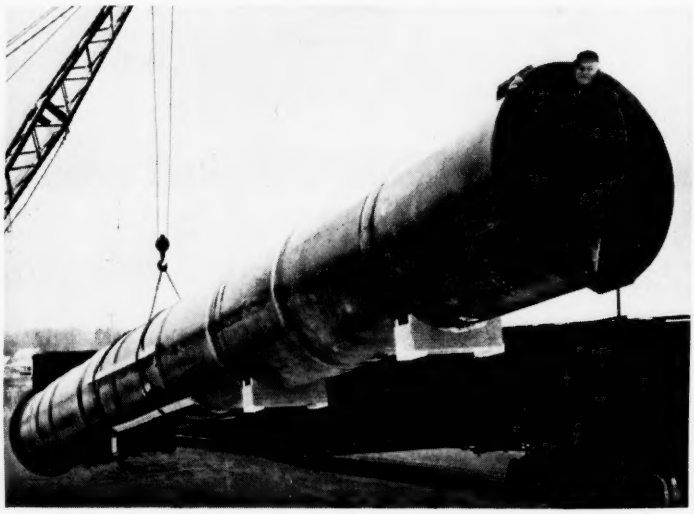
A drum that starts to leak a chemical compound while in transit must be removed immediately to avoid damaging the rest of the cargo, and it can neither be forwarded to its destination nor returned to the shipper while it is leaking. The obvious solution is to transfer the contents to a new drum, but a new one may not be available, and the transfer involves the risk of contamination of the contents. (Many shippers prohibit removal of their products from an original container during transit for this reason.)

The best technique is to repair the drum. But, the patch must be able to withstand considerable handling.

One major carrier now uses an epoxy resin compound for on-the-spot repairs. Arkansas-Best Freight System, Inc., Fort Smith, Ark., handles large quantities of chemicals, and serves an extensive area, stretching from Cleveland to San Antonio.

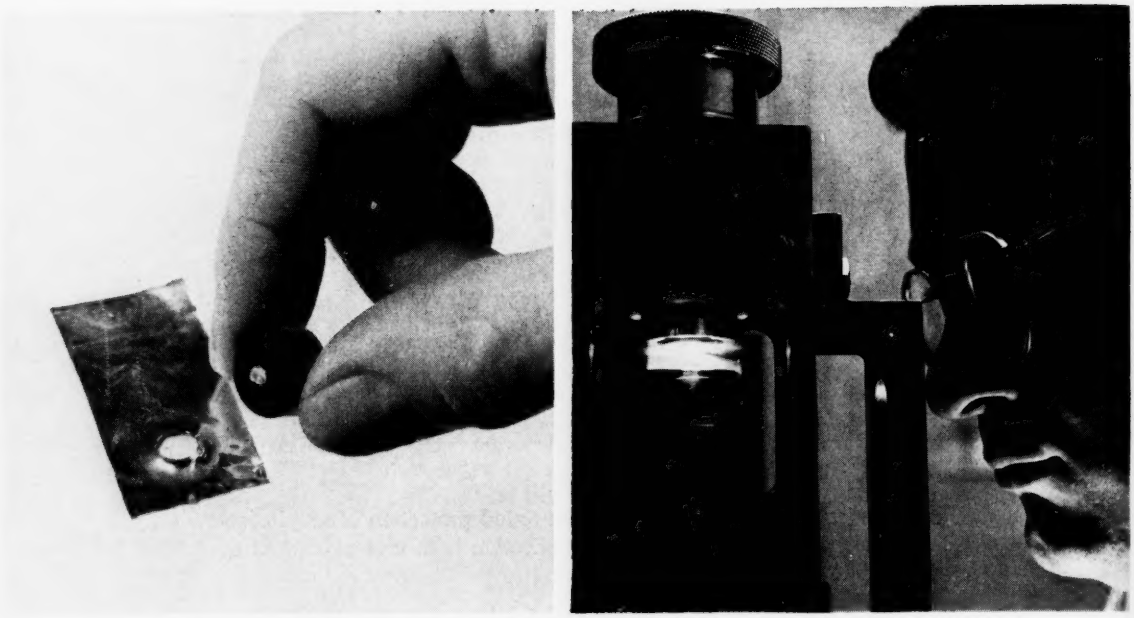
After trying a number of repair materials, the carrier decided on an aluminum-filled epoxy resin. The material is Metalset A-4, made by Smooth-On Mfg. Co., Jersey City, N. J. The drum is cleaned around the rupture and the epoxy compound is applied. The drum is allowed to stand for 24 hours, by which time it is leak-tight. It can then be forwarded to destination without further leakage.

Largest Self-Supporting Plastic Stack



What is said to be the largest self-supporting exhaust stack ever built is shown above, being loaded for shipment to a metal refining plant. There, it will be used to exhaust hot acidic fumes.

Built of reinforced plastic by du Verre, Inc., it will require no steel structure or guys for support, even in winds up to 100 mph. Of tapered construction, it is ¼-in. thick at the top, rests on a base flange over 2-in. thick, will handle 70,000 cu. ft./min. of exhaust fumes.



High-velocity droplets of water penetrate thin pieces of metal and dig craters in heavier metal blocks as Westinghouse researchers . . .

STUDY EROSION WITH SUPERSONIC WATER JETS

"Bullets" of water, fired into blocks of steel are being used by Westinghouse scientists to study complex erosion processes.

Although these experiments add to the general knowledge of erosion processes, the immediate objective is to study the action of water droplets on the rapidly spinning blades of a steam turbine. (High-speed planes and missiles are also eroded as they hit raindrops.) The experiments with single water droplets reduce a very complex process to its simplest, most easily understood, form.

This work was described by S. M. DeCorso and R. E. Kothmann of the Westinghouse research laboratories in Pittsburgh at an American Society for Testing and Materials (ASTM) symposium on erosion.

▶**Supersonic Water-Drop Bullets**—To produce their water bullets, DeCorso and Kothmann fire a small lead pellet down a 30-in. tube, using gas pressures of about 150 psi. behind the pellet. The pellet strikes a small closed reservoir of water, which has a tiny opening pointed in the direction of the sample to be eroded. The impact of the pellet squeezes out a jet of water that travels at speeds up to 3,400 mi./hr., crossing a 1-in. gap before striking the sample's surface.

The slug of water reaches the metal sample in about 15 microseconds. For study, a high-speed camera photographs it at intervals as short as 5 microseconds.

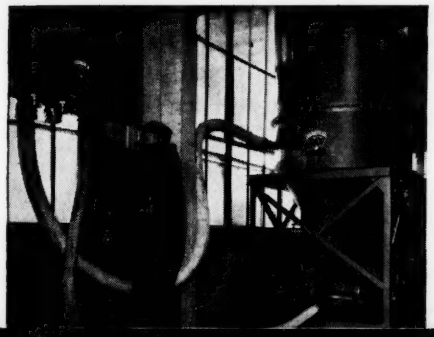
▶**Unexplained Light**—A peculiar light is emitted when the water strikes the metal sample. The light-flash lasts for less than one millionth of a second (one microsecond). Why it is produced at the instant of impact is not yet understood.

The supersonic water jets produce small craters in the metal surfaces that have a profile similar to those produced when high-speed meteorites hit the earth. A numerical scale is being devised for describing the erosion damage quantitatively.

Of the metals tested, Stellite and tungsten carbide have shown the greatest resistance to the high-speed water droplets.

DeCorso and Kothmann also reported the following findings:

- Uniform jets, having a smooth leading face, cause more damage than irregular-shaped jets.
- Irregularities in the metal surface have little effect upon the erosion damage.
- Thin films of water or oil do not protect the metal surface.
- Visible damage, barely seen on the metal surface, appears to correspond to the actual threshold of water erosion damage experienced in the operation of steam turbines.

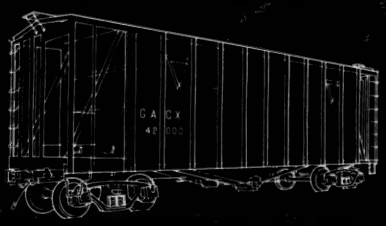


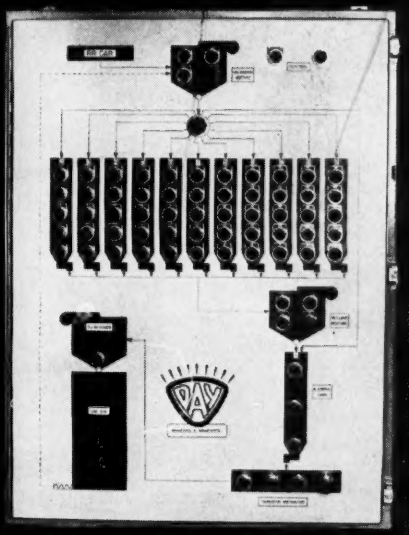
High density pneumatic conveying system for unloading polyethylene pellets from railcar. After piping connections are made, dual-purpose DAY "RJ" receiver, shown right in photo, "pulls" product from railcar and "pushes" it to storage tanks or manufacturing process.

PUSH A BUTTON

START

UNLOAD A RAILCAR





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CPI NEWS BRIEFS . . .

Continued from page 76

Chemical Ltd. High-purity chlorate product comes from salt converted into brine, a basic feedstock for PPG's existing chlorine and caustic soda units at Lake Charles.

Oak Ridge National Laboratory, which Union Carbide Corp. operates for the AEC, has awarded a $341,570 contract to Allis-Chalmers Mfg. Co. to construct a $12-million High Flux Isotope Reactor (HFIR). Expected to be in operation by 1964, the water-cooled, 100-mw. HFIR will boost supply of transplutonium elements by a factor of nearly a million. Principal fission products of the enriched uranium fuel will be curium, berkelium and californium.

Virginia-Carolina Chemical Corp. has hiked its calcined phosphate rock capacity by 400,000 tons/yr. at Nichols, Fla. New hardware includes a closed-circuit television network and a 10 × 160-ft. rotary kiln.

The Martin Co. will build a 10-mw. floating reactor for the Army Corps of Engineers, to supply electricity to port cities or military stations in time of disaster. Initial $644,046 contract is for design only; total project cost is close to $17 million, including construction and testing. Nuclear plant will be built into the hull of a reconditioned Liberty ship, towed to coastal areas when electricity supply is cut off.

Hercules Powder Co. has been awarded an Air Force contract worth "in excess of" $50 million to continue research and development of a third-stage propulsion unit for the solid-fueled Minuteman ICBM. Work will continue chiefly at the firm's Bacchus, Utah, facilities.

Chemetron Corp.'s National Cylinder Gas Div. will build a $1-million air-separation unit at Dallas, Tex., next to Texas Instruments, Inc. Rated capacity will be 120 tons/day of highly pure oxygen, nitrogen and argon. Undisclosed portions of the output will be piped

to Texas Instruments for use in its manufacture of semiconductors and other delicate devices; rest of the gas will be placed on the open market. Chemetron already makes oxygen, nitrogen and acetylene at a separate Dallas site, and currently ships helium and hydrogen in to Texas Instruments.

Monsanto Chemical Co. has placed its 15-million-lb./yr. phthalate esters plant on stream at Long Beach, Calif. Still under construction at Monsanto, N. J., is a similar plant, due for startup next year.

Standard Oil Co. of Ohio has ordered a $100,000 instrumentation package for an in-line blender at its Cleveland refinery. Fischer & Porter Co. has the contract, will supply the turbine flowmeters as well as digital readout and control modules for continuous custom-blending of specification gasolines from 12 stocks and additives.

Armco Steel Corp. has begun operations at an $8.5-million zinc-coating line in Middletown, Ohio. Said to be the widest continuous sheet-galvanizing unit ever built (72 in.), the line requires a strip of steel half a mile long to thread the electronically controlled equipment.

Merck & Co. plans another expansion of its Elkton, Va., coccidiostat plant. (Trademarked Amprol, Merck's product is mixed with feed to combat coccidiosis, a common poultry disease.) Expansion will cost $2 million, double the capacity.

Offices

Thiokol Chemical Corp. has established a regional office in Cocoa Beach, Fla., to coordinate all activities of its Rocket Operations group in the Florida area.

Fairbanks, Morse & Co. has moved certain executive functions to Yonkers, N. Y., but retains its headquarters in Chicago. Moved are the firm's president, corporate vice

presidents, controller, secretary, treasurer, and the entire legal, accounting, public relations and advertising departments.

Olin Mathieson Chemical Corp. has opened a sales office for organic chemicals in Pasadena, Calif.

California Chemical Co.'s Oronite Div. has moved its Chicago sales office to Park Ridge, Ill.

General Electric Co.'s Silicone Products Dept. has opened a sales office in Dayton, Ohio.

Warner Co., Philadelphia producer of construction materials, lime and limestone, has opened an office in Newark, N. J.

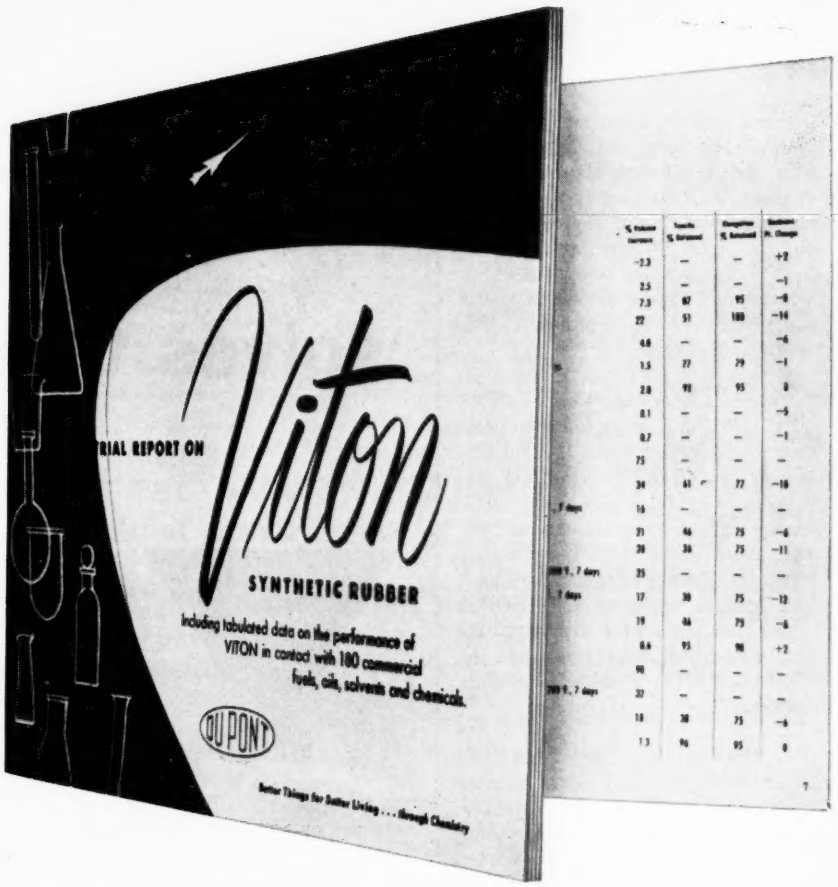
Companies

Ancon Chemical Corp. is the name of the jointly owned firm newly created by Ansul Chemical Co., Marinette, Wis., and Continental Oil Co., Houston, to start producing 60 million lb./yr. of methyl chloride at Lake Charles, La., by early 1962 (*Chem. Eng.*, June 26, p. 74).

Humble Pipe Line Co., Houston, and **Interstate Oil Pipe Line Co.,** Shreveport, La., have merged. New firm retains Humble Pipe Line Co.'s name, becomes a wholly owned affiliate of Humble Oil & Refining Co. Combined pipeline network daily pumps more than 1 million bbl. of crude oil and products—making it the nation's largest.

Fluor-Singmaster & Breyer, Inc., is the new name of Singmaster & Breyer, Inc., an engineering subsidiary of The Fluor Corp., Ltd. Simultaneously with its name change, the firm moved to new headquarters at 100 Park Ave., New York.

Diamond Alkali Co. has acquired all the stock of Chemical Process Co. that was formerly held by Commercial Solvents Corp., thus ending a bitter battle that has raged all



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In a refinery valve, *seat and O-rings of* VITON *still give positive shutoff after more than a year's service with benzene!*

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COMPLETE HEAT AND FLUID RESISTANCE DATA—Seals, gaskets, hose and other products made of VITON perform at temperatures from −40° F. to +600° F. "Industrial Report on VITON" gives more details, and outlines VITON's resistance to 180 commercial fluids.

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This reference booklet, with its new up-dated information, should be in *your* permanent materials file. Fill in and mail the coupon below for your copy. For information on specific parts made of VITON, and how they can cut your operating costs, see your rubber goods supplier. E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department CE-9, Wilmington 98, Delaware.

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summer between the two for control of the Redwood City, Calif., firm. Diamond now claims control of more than 80% of the outstanding shares of Chemical Process Co., and is "offering the opportunity" to the remaining stockholders to sell out at $15/share (which is the same price paid to Commercial Solvents and others).

Spencer Chemical Co., Kansas City, Mo., has acquired two suppliers of polyethylene, cellophane, laminates and other packaging materials: Crystal Tube Corp., Chicago, and Flexicraft Industries, Inc., New York. Both become subsidiaries. Terms were not disclosed, but Spencer president J. C. Denton notes that the moves are part of a "planned diversification into the $550-million/yr. flexible packaging industry."

The Borden Co., New York, has acquired Columbus Coated Fabrics Corp., Columbus, Ohio. A manufacturer of oil, nitrocellulose, polyvinyl chloride and acrylic-coated fabrics, Columbus will retain its name and management but operate as a division of Borden.

International

West Germany: Deutsch BP und California is a newly created partnership between BP Benzin und Petroleum A.G. and California Chemical GmbH. to operate an aromatics plant at Dinslaken. An adjoining refinery will feed the petrochemical unit, designed to turn out an initial 14,000 metric tons/yr. of high-purity *p*-xylene. Due on stream by the middle of next year, project parallels a similar venture in England (*Chem. Eng.*, Nov. 14, 1960, p. 268).

Sweden's first ethylene oxide plant will be a 33-million-lb./yr. direct air oxidation installation at Stenungsund. Mo och Domsjo A.B., Ornskoldsvik, has awarded a construction contract to Scientific Design Co., New York. Stenungsund area is turning into the headquar-

4 PH Stainless Steel

e valve problems

Provides combination of properties that minimize galling, erosion, abrasion, cavitation and corrosion at low cost.

Armco 17-4 PH Stainless Steel eliminates troublesome and costly valve maintenance because it combines high hardness and strength up to 900 F with excellent corrosion resistance. This special stainless provides the mechanical properties of the regular hardenable stainless grades and corrosion resistance comparable to Type 304.

Typical Mechanical Properties–In Condition H 900, 17-4 PH has a tensile yield strength of 185,000 psi, an endurance limit at 10,000,000 cycles of 90,000 psi, and a Rockwell hardness of C44. A range of properties can be obtained by varying the hardening temperature.

Corrosion Resistance–Superior to all the standard hardenable stainless grades. Laboratory and service experience demonstrate that in most media 17-4 PH resists corrosion as well as Type 304. Excellent corrosion resistance combined with high hardness minimizes corrosion-erosion and cavitation.

This special precipitation-hardening Armco Stainless Steel is giving excellent service in stems, guide bushings, plugs, balls, wedges, discs, bolts and trim. For the valves you make or use, take advantage of the economy and superior performance possible with Armco 17-4 PH Stainless Steel.

Write us or contact your Distributor of Armco Stainless Steel for complete information. **Armco Division, Armco Steel Corporation, 2851 Curtis Street, Middletown, Ohio.**

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Chicago, Ill. – Cincinnati – Detroit – Milwaukee

CHICAGO STEEL SERVICE COMPANY (AB)
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CLEVELAND TOOL & SUPPLY COMPANY (B)
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THE CONGDON AND CARPENTER COMPANY (AB)
Providence, R. I. – Fall River, Mass. – Natick, Mass.

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DUCOMMUN METALS & SUPPLY COMPANY (AB)
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FIRTH BROWN STEELS LTD. (AB)
Montreal, P. Q. – Toronto

GATE CITY STEEL, INC.–OMAHA (AB)
Omaha, Nebr. – Columbus, Nebr.

INDUSTRIAL STAINLESS STEELS, INC. (B)
Cambridge, Mass. – Buffalo, N. Y.

EARLE M. JORGENSEN COMPANY (AB)
Los Angeles, Calif. – Dallas – Denver – Honolulu – Houston – Oakland – Phoenix – Seattle – Tulsa – Wichita

MAPES & SPROWL STEEL COMPANY (AB)
Union, N. J.

METAL GOODS CORPORATION (AB)
St. Louis, Mo. – Dallas – Denver – Houston – Memphis – New Orleans – N. Kansas City, Mo. – Tulsa – Wichita

MONCRIEF-LENOIR MFG. COMPANY (AB)
Houston, Texas – Dallas – Harlingen – Lubbock – San Antonio – Temple

MORRISON STEEL COMPANY (AB)
New Brunswick, N. J.

THE ORLEANS STEEL PRODUCTS COMPANY, INC. (A)
New Orleans, La.

WILLIAM M. ORR COMPANY, INC. (AB)
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PAPER-CALMENSON & COMPANY (A)
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SOUTHER STEEL & ALUMINUM COMPANY (A)
St. Louis, Mo.

J. M. TULL METAL & SUPPLY CO., INC. (AB)
Atlanta, Ga. – Birmingham – Greenville, S. C. – Jacksonville – Miami – Tampa

VIKING STEEL COMPANY (AB)
Cleveland, Ohio

VORYS BROTHERS, INC. (AB)
Columbus, Ohio

YORK CORRUGATING COMPANY (A)
York, Pa. – Washington, D. C.

ters of Sweden's budding petrochemical industry, representing a current capital investment of about $40 million (including Svenska Esso A.B.'s steam-cracking ethylene unit, which will feed Mo och Domsjo's oxide plant).

India has been extended $120 million in foreign-exchange credit for a period of 12 years by ENI, Italy's oil-and-gas state monopoly. The Italian offer covers foreign exchange components of four projects, for which India herself must supply the remaining rupee costs: (1) $34 million will go toward a gas separation plant, a lube-oil installation, and a naphtha cracker to feed unspecified petrochemical units at an undecided site; (2) $33 million is tagged for a refinery tentatively proposed for a south Indian location, to be fed on imported crude; (3) another $33 million will help finance two pipelines, to be laid from Barauni to Calcutta and either from Barauni to Kanpur or Lucknow to Delhi; (4) $20 million is for oil and gas exploration by India's Oil & Natural Gas Commission.

Greece has been presented with a check for $350,000 by the U. S. AEC under its Atoms-for-Peace program. Gift is toward the cost of a 1-mw. "swimming pool" nuclear reactor that went critical in July at the Democritos Nuclear Center at Aghia Paraskevi, near Athens. The center is named for the man who gave the word *atom* to the world in the fifth century B.C.

Canada: Dow Chemical Co. of Canada, Ltd., has brought on stream its Fort Saskatchewan, Alta., petrochemical facilities. Fed by natural gas or separated LPG, units produce undisclosed quantities of pentachlorophenol, dichlorophenol, ethylene, ethylene oxide, ethanolamines and glycols (*Chem. Eng.*, April 18, 1960, p. 223).

Brazil: The Firestone Tire & Rubber Co. will operate a 27,500-metric ton/yr. polybutadiene plant in Recife, construction of which will be begun this fall by The Lummus

ONE OF A SERIES OF CHATS ABOUT THE CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

DOWNTIME DOWN —OUTPUT UP

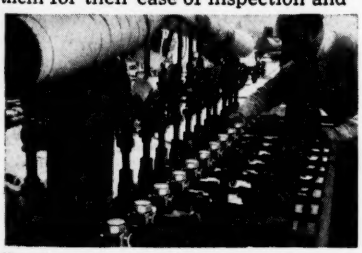
Continuous processing . . . two big words in the world of chemicals . . . and one big headache when the processing has to stop unexpectedly. It's not just the pure pain in the neck that mechanical failure produces. It's the production costs that keep mounting during down-time.

Let's face it, no one can eliminate every bug. But steam trap failure is a bug there's no excuse for. Not since Sarco created the Thermo-Dynamic Steam Trap, Type TD-50.

For example, Reichhold Chemicals know how bugless it is. They have standardized on this unique steam trap in their new Maleic Anhydride plant at Elizabeth, New Jersey. Of their 320 TD-50's, most are in service on 35-lb. steam tracer lines.

Results? Results!

For one thing, Reichhold has learned that TD-50's hardly know the meaning of the word downtime. Then, too, maintenance people like them for their ease of inspection and service. And TD-50's don't require high quality steam to function.



The character pretending to inspect one of Reichhold's TD-50's is Sarco's ad manager, who normally wears a gray flannel suit. We're happy to see strainers used properly on this 14-trap manifold to protect the steam traps, even if they don't happen to be Sarco strainers.

We don't want to sound like an advertisement, but it's this way: the TD-50 is so simply designed it has only one moving part; its performance is uniform; it operates equally well on heavy, light, or no condensate load — even against back pressures up to 50% of inlet pressures; it's so rugged that superheat, water hammer, vibration, or corrosive condensate won't affect it; if you should ever want to service a TD-50, a highly unlikely prospect, you can unscrew the cap, clean it, blow it down, and have it back on stream in 40 seconds.

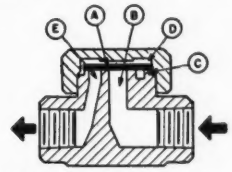
MR. BERNOULLI HELPS BUILD A BETTER STEAM TRAP

We may be a trifle tardy in bringing it up, but Daniel Bernoulli, who dreamed up the "Bernoulli Effect" about 250 years ago, deserves some sort of accolade from us here at Sarco. A plaque perhaps, or his name in the foyer floor tile. Daniel was a famous Swiss mathematical genius and he was probably a little hesitant about even mentioning his slightly offbeat discovery, the "Effect," in *Hydrodynamica* (1738).

If you happen to have a spool handy, you can perform the simple "effect" right at your desk. Lay a cardboard disc with a pin through it on the table. Place the spool over the pin and blow—hard—and lift. The disc won't fall until you stop blowing because the air under pressure expands between the end of the spool and the disc. The pressure in this space is actually less than atmospheric, and the sum of the downward forces is less than the upward force of atmospheric pressure acting upon the disc's bottom side.

Well, of course it *sounds* rather remote, but what seemed like a simple parlor trick to Bernoulli has made it possible for us at Sarco to solve steam trapping problems by the dozens. In our Sarco Thermo-Dynamic Steam Trap, Type TD-50, the cardboard disc is replaced by a stainless steel disc A, the spool tube by inlet tube B. The disc also acts as a valve and can seat on B, and also on outer seat ring C. When seated, the disc seals the inlet and the chamber D from the outlet E.

Full attention now, because it could easily be *your* steam, condensate, or air we're following here as it enters the trap, its pressure raising the disc and allowing fluid to flow radially across the underside of the disc. The velocity of air or condensate is comparatively low, exerting little influence on the disc, which remains



clear of the seat, allowing free discharge. Ah, but now steam enters the trap. Velocity increases greatly because of the steam's greater internal energy. Presto! The disc is pulled toward the seat just as was the cardboard. At the same time, the radial steam jet raises the pressure in D by recompression, snapping the disc down on the seat.

Downward force of recompressed steam in D, acting on the full area of the disc, is greater than the upward force of the inlet steam acting on the smaller area of the inlet orifice. So the disc remains seated, stopping all flow of steam, until pressure in D is reduced by condensation, and the cycle is repeated.

BEYOND THE TD-50 PRINCIPLE

Surprise! In spite of the one-track subject matter you've had the decency to ingest so far, we manufacture a good deal more than TD-50's. As a matter of proud fact, we are the only company that makes and sells all five types of steam traps. After all, there is a place for Balanced Pressure Thermostatic, Float Thermostatic, Camlift Bucket, and Liquid Expansion Thermostatic Steam Traps too. And our knowledgeable engineers can tell you exactly where to use what—and how.

And may we modestly add, that's only the beginning? As long as our present conversation seems to consist of product name dropping, we'll just mention the fact that we make exceptionally fine pressure and temperature regulators of rather astonishing variety and ingenuity. For example, we have a complete line of self-powered regulators for heating and cooling. And to make most effective use of these last few lines—strainers of all kinds—even hand and motor operated scraper strainer types. We could fill this page with lists of applications, testimonials, and specifications, but it would be eminently more sensible simply to say: Tell us your problem.

Write us direct, or contact your local Sarco sales representative or sales office.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both—to the point where you'll communicate. 5902

SARCO

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STRAINERS • HEATING SPECIALTIES

Co. First of its kind in South America, the unit is due on stream in about two years. Feedstock will be alcohol derived from the vast sugar cane plantings in the Recife area.

West Germany: Bayerische Berghuetten und Salzwerke A.G., the state-held mining company, has discovered what it believes to be the continent's largest thorium deposit. Located in the Bavarian mountains near the Czech border, the deposit is deeply bedded in granite. One ton of the rock is estimated to hold 2,500 g. of thorium, 100-150 g. of uranium.

Canada: Price Brothers & Co., currently building a $22-million addition to its Kenogami, Que., pulp and paper facilities, plans to spend $4.5 million more to install an additional paper mill in the plant. Due on stream next April (plant expansion itself is scheduled for completion this December), the new machine will turn out 130 tons of newsprint or 100 tons of kraft paper daily, replacing a 90-ton/day newsprint mill.

Japan soon may have two huge new steel mills, if current tentative plans go through. Aichi Steel Works, Ltd., is "studying the possibility" of a steel facility in Nagoya's industrial belt, aiming at a long-range capacity to hit 1 million tons/yr. by 1970; and Yawata Iron & Steel Co., the country's largest steelmaker, is eyeing Kizarazu in Chiba prefecture, across Tokyo Bay, for a gargantuan, $141.5-million installation. Drawback to Yawata's plan: the Kizarazu site is currently tenanted jointly by the U. S. Navy and the Japan Maritime Self-Defense Forces.

Great Britain: Scottish Gas Board's $18.5-million gasification plant has been officially opened by H. M. Queen Elizabeth at Westfield, Fife, in eastern Scotland. The U. K.'s first Lurgi high-pressure gasification unit, it has a rated capacity of 15 million std. cu. ft./day (about a fifth of Scotland's present consumption of

town gas)—and is already scheduled for expansion to 30 million std. cu. ft./day. Humphreys & Glasgow Ltd., London, constructed it.

Canada: Rayonier Canada Ltd. has completed a $15-million expansion and modernization of its pulp and paper mill at Woodfibre, B. C. Closed since 1958, revamped plant can turn out 250 tons/day of bleached kraft pulp from hemlock, cedar and fir. Virtually all will be exported.

Austria: Danubia Petrochemie A.G. has placed its 10-million-lb./yr. polypropylene plant on stream at Schwechat, near Vienna. Adjacent refinery feeds the unit, which marks the first polypropylene production in the country. Danubia is a joint subsidiary of Oesterreichische Stickstoffwerke A.G., Linz-Donau, Austria's state-controlled — and largest — chemical firm, with Italy's Montecatini.

Chile: Industrias Forestales S.A. has ordered $10 million worth of equipment for a 60,000-ton/yr. newsprint mill at Naciemiento in southern Chile. John Inglis Co., Toronto, will deliver the equipment by early 1963.

Netherlands: Imperial Chemical Industries Ltd. plans a $19.6-million acrylic products plant at Rotterdam. Production is due to begin by the end of 1963, representing the first step in ICI's plan to invest some $280 million in Europe over the next decade.

France: United Carbon France S.A., a subsidiary of United Carbon Co., Houston, has placed its 50-million-lb./yr. carbon black plant on stream at Port Jerome, center of the French rubber industry. The $5-million installation was constructed by Compagnie Francaise d'Enterprises.

Brazil: Petroleo Brasileiro, S.A., will build a 29,000-metric ton/yr. butadiene plant at its synthetic rubber complex in Duque de Caxias, near Rio de Janeiro. Petrobras has licensed the Houdry de-

hydrogenation route, which turns out the petrochemical from normal butane and butenes. Firm already has two Houdriforming units under construction near Rio and Sao Paulo.

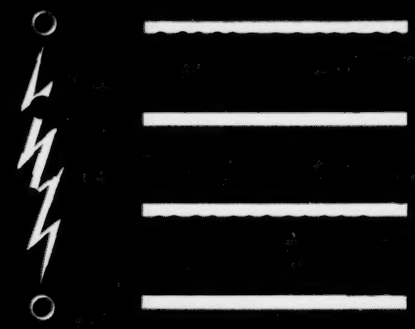
Iraq's $22.4-million rayon project is finally getting under way, after a delay of five years. The country's Ministry of Industry has signed a contract with Ing. Maurer S.A., a Swiss industrial consulting firm headquartered in Berne, to engineer the unit for the town of Hindiya Barrage, near Baghdad. Initial capacity would be 3,000 tons/yr. of rayon yarn and 5,000 tons/yr. of staple fiber, both now slated to come on stream by early 1964.

Netherlands: Petrochemie Aku-Amoco N.V. has been created by Amoco International, S.A., and Algemene Kunstzijde Unie N.V. ("AKU") to make and market dimethyl terephthalate from *p*-xylene at Delfzijl. Due on stream in 1963, new plant will use the oxidation route that Amoco Chemicals Corp. now has on stream at Joliet, Ill. Dimethyl terephthalate is a raw material for polyester fibers and yarns, which AKU makes at Arnheim.

In a separate development, another AKU Dutch subsidiary—Silenka Aku-Pittsburgh N.V., owned jointly with Pittsburgh Plate Glass International—plans a textile-yarn glass fiber plant at Hoogezand. Construction will begin in October, with completion scheduled for late next year. Furnaces will turn out glass yarn, roving, chopped strand, and mat.

Canada: Sherritt Gordon Mines Ltd., Toronto, plans to have 35,000 tons/yr. of urea capacity on stream by the second half of next year at Fort Saskatchewan, Alta. Product will come in either crystal or prill form, containing 46% nitrogen. Estimated cost to build the plant: $3 million.

Great Britain: The Du Pont Co. (United Kingdom) Ltd. will build a multimillion-dollar isocyanates plant at Maydown, near Londonderry in North Ireland. Construc-



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tion begins this fall or early winter, with completion slated for late 1963. Capacity is undisclosed.

Canada: Shawinigan Chemicals Ltd., a partially owned subsidiary of The Shawinigan Water and Power Co., is constructing a $20-million petrochemical plant at Varennes, Que., on the banks of the St. Lawrence near Montreal. An associated $45-million, 300,000-kw. thermal electric station will be built at nearby Tracy, with half the capacity scheduled to begin operating in mid-1964; the other half, a year later. Ethylene, propylene and other undisclosed "basic building blocks" will be produced at the petrochemical facility, which is due on stream in mid-1963. Feed will come from British American Oil Co. Ltd.'s Montreal East refinery. (Coincidentally, British American Oil will relinquish its 50% holdings in B.A.-Shawinigan Ltd. to Shawinigan Chemicals Ltd., which owns the other 50%, in return for a 25% interest in Shawinigan Chemicals Ltd. itself.)

People

Gerald L. Phillippe and **Cramer W. LaPierre** have been elected president and executive vice president, respectively, of General Electric Co. Both become directors as well.

Steven J. Taussig and **Harry H. Higa** have been appointed technical director and chief biochemist, respectively, at Pacific Laboratories, Inc. The Honolulu firm recently stirred considerable trade interest (*Chem. Eng.*, April 17, p. 117) with a new hydrolytic enzymes route, based on a revolutionary theory of Japan's Toyosaku Minagawa.

John M. Archiable has been picked for the board of directors of Emery Industries, Inc.

Carl E. Barnes has joined FMC Corp. as vice president for research. He comes from eight years

in the same position at Minnesota Mining & Mfg. Co.; replacing him there is **Charles W. Walton**, formerly vice president and general manager of 3M's adhesives, coatings and sealers division.

John N. Dempsey has been named director of Minneapolis-Honeywell Regulator Co.'s research center.

C. W. Nofsinger is the new vice chairman of the board at Western Petrochemical Corp.

Francis W. Theis has been elected vice president—international at Pittsburgh Plate Glass Co. **Bjorn Holmstrom** replaces him as president of Pittsburgh Plate Glass International, S.A., a Geneva-based subsidiary.

D. M. Gillies is the new director of research for Union Carbide Metals Co., a division of Union Carbide Corp. He moves up from an assistant directorship at another Carbide division, Linde Co.

Richard P. Klopp has been elected director and vice president in charge of sales for Catalytic Construction Co.

James McWhirter, general manager of Pennsalt Chemicals Corp.'s Industrial Chemicals Div., has been elected a vice president of the corporation.

Robert A. Charpie has been appointed manager of advanced developments for Union Carbide Corp. Since 1955, Charpie had been assistant director of Oak Ridge National Laboratory, which Carbide operates for the AEC.

Carl T. Lenk has been appointed manager of inorganic research at Wyandotte Chemicals Corp.

Curry E. Ford is the new director of development for National Carbon Co.

Raymond H. Hartigan has been named director of the research division of Rensselaer Polytechnic Institute.

Convention Calendar

September

11-15. Instrument Society of America, 16th Annual Instrument, Automation Conference & Exhibit, Biltmore Hotel and Memorial Sports Arena, Los Angeles, Calif.

11-15. National Industrial Conference Board, Stanford Research Institute, International Industrial Conference, Fairmont Hotel, San Francisco, Calif.

12-15. Pennsylvania State University, Seminar for Manufacturing Engineers, University Park, Penna.

13-15. National Petroleum Assn., Annual Meeting, Traymore Hotel, Atlantic City, N. J.

14-15. American Society of Mechanical Engineers, American Institute of Electrical Engineers, Engineering Management Conference, Hotel Roosevelt, New York, N. Y.

17-22. Pennsylvania State University, Work Measurement Course, University Park, Penna.

17-20. American Institute of Electrical Engineers, Annual Electric Conference of the Petroleum Industry, Jung Hotel, New Orleans, La.

18-20. Canadian Agricultural Chemicals Assn., 9th Annual Meeting and Conference, Mont Tremblant Lodge, Mont Tremblant, Que.

18-20. Standards Engineers Society, Annual Meeting, Hotel Sherman, Chicago, Ill.

20-21. American Institute of Electrical Engineers, Instrument Society of America, Institute of Radio Engineers, Industrial Electronics Symposium, Bradford Hotel, Boston, Mass.

22-1. Ist International Plastics Fair of Denmark, Forum, Copenhagen, Denmark.

24-27. American Institute of Electrical Engineers, American Society of Mechanical Engineers, National Power Conference, St. Francis Hotel, San Francisco, Calif.

24-27. American Institute of Chemical Engineers, National Meeting, Lake Placid, N. Y.

24-27. American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference, Muehlebach Hotel, Kansas City, Mo.

25-28. American Welding Society, Fall Meeting, Adolphus Hotel, Dallas, Tex.

25-28. Industrial Building Exposition & Congress, New York Coliseum, New York, N. Y.

28-29. American Production and Inventory Control Society, 4th Annual National Conference and Technical Exhibit, Pick-Congress Hotel, Chicago.

28-30. American Society for Quality Control, Chemical Div., 5th Annual Chemical Conference, Daniel Boone Hotel, Charleston, W. Va.

October

2-3. Engineers Council for Professional Development, 29th Annual Meeting, Sheraton Seelbach Hotel, Louisville, Ky.

2-7. International Astronautical Federation, 12th International Astronautical Congress, Washington, D. C.

3-4. Southern Research Institute, Coal Technology Conference, Birmingham, Ala.

4-6. American Society of Mechanical Engineers, Process Industries Conference, Shamrock-Hilton Hotel, Houston, Tex.

5-7. American Society of Mechanical Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, 24th Annual Joint Solid Fuels Conference, Dinkler-Tutwiler Hotel, Birmingham, Ala.

6-7. American Society for Engineering Education, Annual North Midwest Meeting, Michigan College of Mining and Technology, Houghton, Mich.

8-11. American Institute of Mining, Metallurgical and Petroleum Engineers, Society of Petroleum Engineers, Fall Meeting, Dallas, Tex.

8-12. Water Pollution Control Federation, Milwaukee Auditorium and Schroeder Hotel, Milwaukee, Wisc.

9-11. Technical Assn. of the Pulp & Paper Industry, Plastics Paper Conference, French Lick-Sheraton Hotel, French Lick, Ind.

11-12. CHEMICAL ENGINEERING and Armour Research Foundation, Conference on the New Trends in Chemistry, Sheraton Towers Hotel, Chicago, Ill.

Later

November 27-December 1. 28th Exposition of the Chemical Industries, New York Coliseum, New York, N. Y.

Continued from page 88

the device starts integrating only when the input signal is greater than a desired minimum threshold value.

In addition to quantitative measurements of chromatograms, the device computes spectroscopic-spectrographic, flow and power data, and other recorded information. — **Ridgefield Instrument Group, div. of Schlumberger Corp., Ridgefield, Conn.** 88D

Vacuum control

Unit automatically maintains level of pressure from 40-1,000 microns.

A 10-lb. unit automatically opens and closes 5-amp. contacts at preselected pressures from 40 to 1,000 microns Hg pressure, for vacuum furnaces and pumping systems. The contacts operate external circuits, to control power, run a diffusion pump, sound an alarm or turn on signal lights, and open or close valves.

Protecting vacuum levels in operational equipment equally well under conditions of either rising or falling pressure, the device continues to read pressure past the selected vacuum level and automatically resets when the system returns to operating pressure.— **NRC Equipment Corp., Newton, Mass.** 182A

Microscope attachments

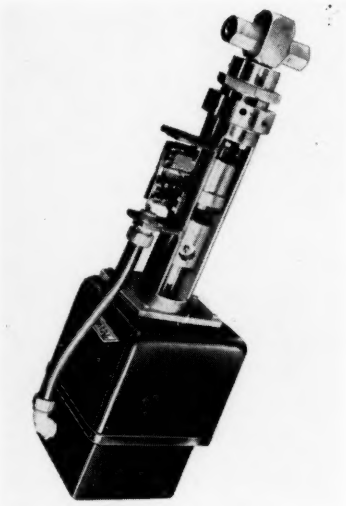
Electron microscope can heat, chill, take motion pictures of changes.

Various attachments for a standard electron microscope broadly extend its versatility, permit the specimen to be heated, chilled or deformed while it is in the microscope. Motion pictures may be

taken to record the changes that occur.

With continuous direct magnification from 600 to 200,000X, it is possible to examine large areas of the specimen at low magnification, then sweep to high magnification to study selected parts without having to reconvert the instrument.

With the attachments, it is possible to heat a specimen to 1,000 C., cool it to –140 C., or even elongate a metal film as much as 55 microns. Moment-by-moment record of changes can be made with a 16-mm. camera, either by exposing the film one frame at a time or by taking motion pictures at 1.5, 3 or 6 frames/sec.—**Fisher Scientific Co., Pittsburgh.** 182B

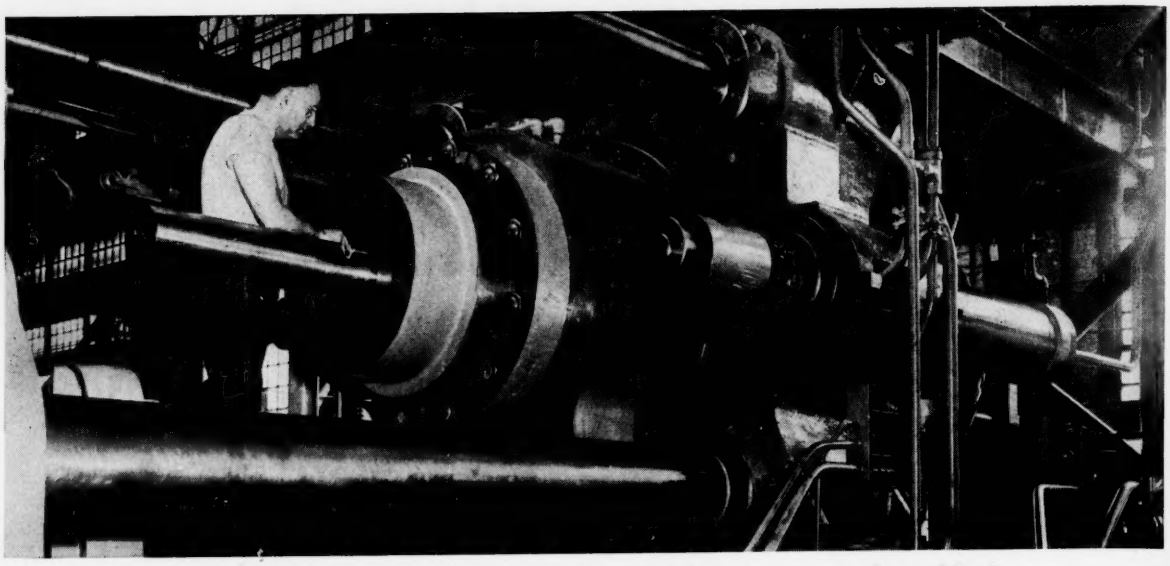


Valve actuator

Electronic unit can operate any reciprocating or rotary-stem valve.

Originally developed for handling high-pressure fluids in radioactive installations, an electronic valve operator that works from standard 115-v. power can be mounted on any type of reciprocating or rotary-stem valve.

The unit contains a balancing relay assembly that accepts any type of a.c. or d.c. control signal, producing a demand signal that controls the rotation of an oil-immersed gear motor, which in turn is mechanically linked to the valve



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stem. Output torque is from 25 to 150 ft.-lb. at ½ to 5 rpm.—**Reliance Instrument Div., Electro-Mech Corp., Norwood, N.J.** 183A

Polyethylene-steel drum

Tight fit of plastic liner permits drum to be handled normally.

The corrosion resistance of polyethylene and the strength of steel are merged in this combination 55-gal. drum for products requiring an inert lining surface with strong outside covering.

Due to the full-width opening of the liner, liquid and solid materials may be dumped into or emptied from the container in the normal way. Materials can be interchanged if liner is properly cleansed.

Completely removable, liner can be used separately from the steel overpack. For handling and transportation, the drum is closed with a tight-fitting polyethylene cover and sealed with a ring.—**Redmanson Corp., York, Pa.** 185A

High-pressure valve

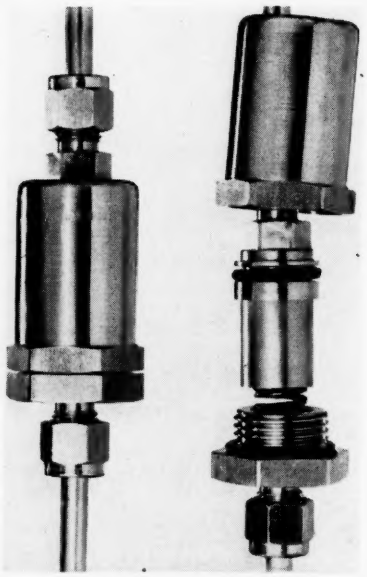
Suitable for service above 3,000 psi., it has a large flow passage.

High-pressure gas is contained with minimum leakage in this valve that features open flow passages to minimize pressure drop. Maximum leakage is said to be only 4 cc./hr.

The main seal is a resilient Tef-

lon ring. When the valve opens, a pressure differential is created that forces the seat out of the path of any foreign particles in the gas stream. When the valve closes, an overlapping metal seat prevents the Teflon from cold-flowing.

The pilot section is prevented from chattering by a combined pneumatic load and conventional spring. Extremely fast electrical-response times are claimed when the unit is equipped with special solenoids. Valve maintenance can be done in the field.—**Valcor Engineering Co., Kenilworth, N. J. 185B**



Inline filter

Element can be replaced without removing housing from pipe.

To replace the filter element on this inline filter, simply unscrew the housing, slide it up a few inches on the pipe, and remove the element. Replacement time is reduced to a minimum.

Various micron-size elements can be supplied in Type 316 sintered stainless steel. The housing is available in brass or stainless steel, with elastomer O-rings and rubber gaskets. Large filtering area is said to minimize pressure drop and increase element life when filtering instrument air,

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For descriptive literature on BS&B Quik-Sert, write to Black, Sivalls & Bryson, Inc., 7500 East 12th St., Kansas City, Missouri.

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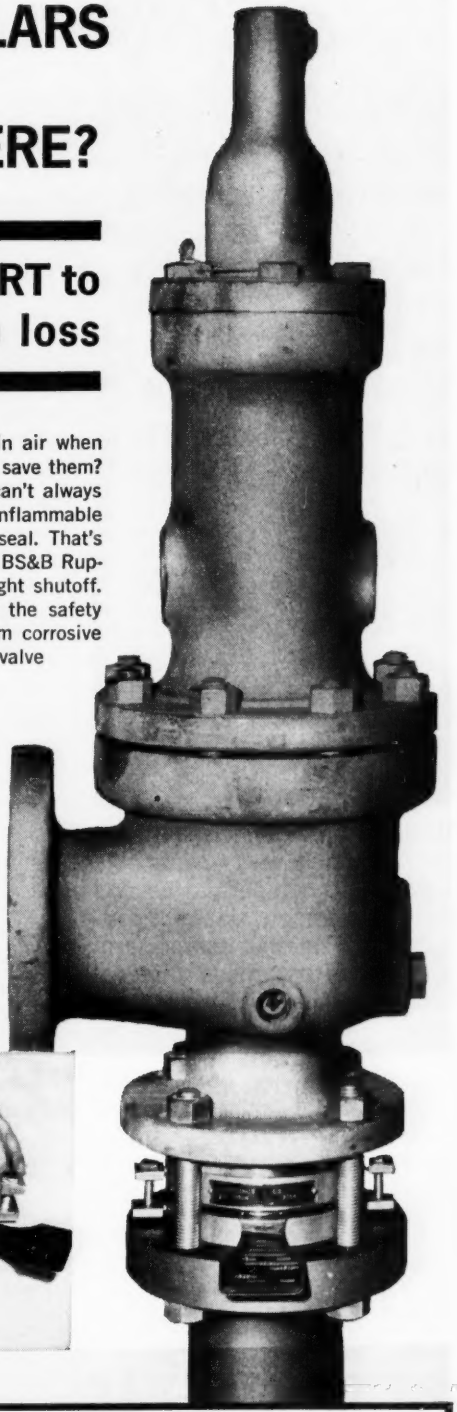

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control system fluid and coolant for machines and electronic equipment.—**Nuclear Products Co., Cleveland.** 186A

Portable recorder

Versatile unit accepts up to six signals; inputs can be varied.

A single recording mechanism and strip chart can record any number and combination of variables, using proper sensing elements and plug-in signal modules.

Standard unit has from two to six channels, each of which can read and record different variables such as temperature, voltage, current, light intensity, humidity, air movement, moisture, displacement and pressure. Scan rates are from 2 to 12 sec. per channel. If desired, any recorder may be operated as a single-channel unit.—**Tipptronic, Inc., Chagrin Falls, Ohio.** 188A

Liquid meter

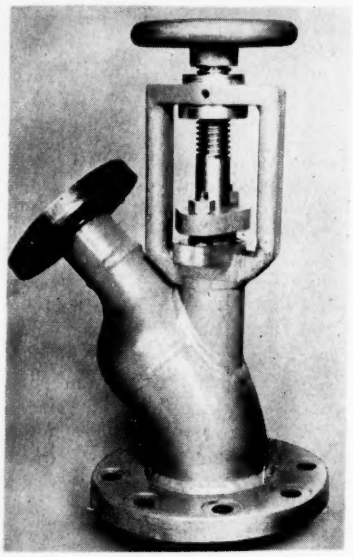
Positive-displacement unit measures up to 25 gpm. of liquid.

Requiring only 4-18 in. of water to operate, an integrating liquid flowmeter is designed to measure the passage of nonviscous and nonvolatile liquids. Accuracy is said to be ±1% at any rate of flow from zero to the unit's full rated capacity.

The meter consists of a cylin-

drical copper drum revolving inside a cast iron case. The drum is divided into six scroll-shaped compartments, each of which fills and overflows into the next, measuring a fixed volume as it discharges. The rotary motion of the drum is transmitted to a calibrated counter that shows throughput directly in gallons.

Pressure at the discharge should not exceed atmospheric, although with a suitable level controller, the unit can handle up to 25 psi. Capacity range is ½ to 25 gpm. in seven models.—**Central Station Steam Co., Detroit. 188B**



Plug valve

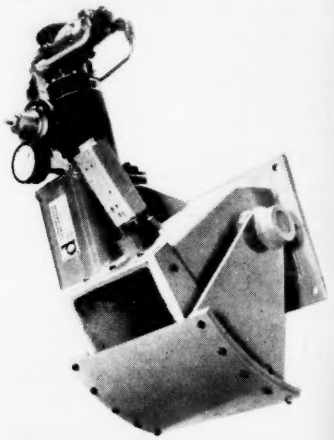
No material can collect between valve outlet and process vessel.

There is no pocket between vessel and outlet pipe to collect unprocessed materials or to trap catalyst on a flush-type plug valve with either receding or extending plug.

Available for pressures to 300 psi. or higher, the valve can be modified to give discharge at any angle, to provide a long body for use with direct-fired vessels, or to include pneumatic or hydraulic cylinder operators or extended shafts.

Sizes range from 1 to 10 in., with standard pipe flange spacing for holes in connecting and discharge

flanges.—**Economy Mfg. Co., East Liverpool, Ohio.** 189A



Swing-gate feeder

Device controls movement of free-flowing material into process.

A swing-gate feeder, available in a wide range of flow rates, controls rate of passage of free-flowing materials into automatic weighing systems or continuous process streams.

It comes with either two-position off-on control, or with modulated feed control to regulate flow rate from maximum to cutoff.—**Dynametrics Corp., Burlington, Mass.** 190A

Catalyst loader

Device distributes and dispenses material into multitube reactors.

How to fill a plurality of closely spaced tubes with catalyst or

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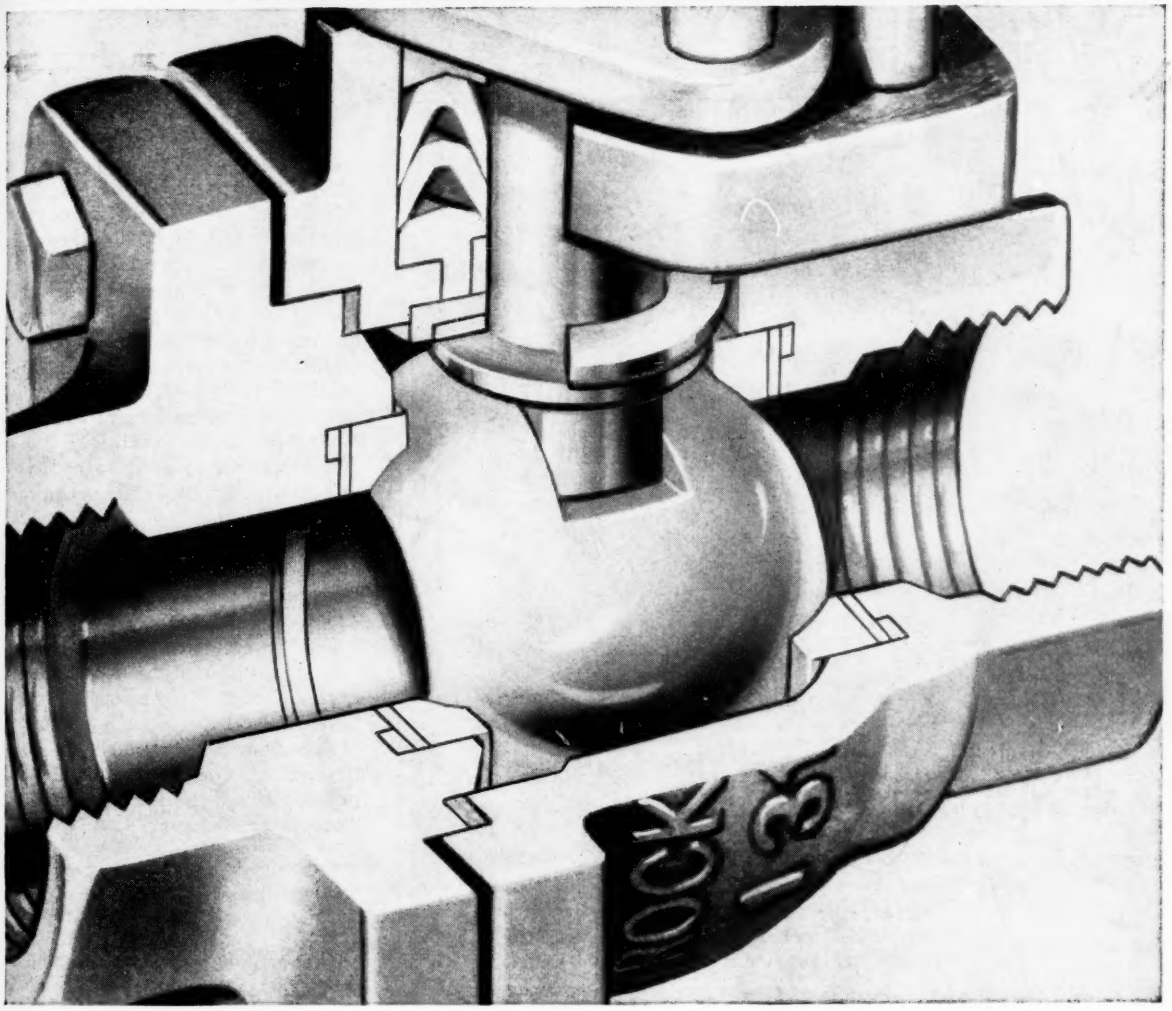

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ROCKWOOD

BALL VALVES

other material without spilling or overfilling is neatly solved by a loader that distributes and dispenses measured, equal amounts of catalyst into multitube reactors.

The unit consists of a battery of pipes sized to hold a specific volume of the material to be charged, with flexible connections above and below the pipes. By moving top and bottom plates attached to the bank of flexible connections, the elastic tubing can be made to flex so as to seal the pipe during filling or handling.

A measured amount of catalyst or other material is charged to the unit, which is then raised by a crane to a position over a reactor, and the charge is permitted to flow from each pipe into the reactor tubes.

The volumetric measuring system involved can be used wherever a free-flowing material must be handled and dispensed in unit charges, such as automatic additions of dry bulk or fluids to batch processes. — **James H. Howard & Associates, Houston.** **190B**

Continuous filter

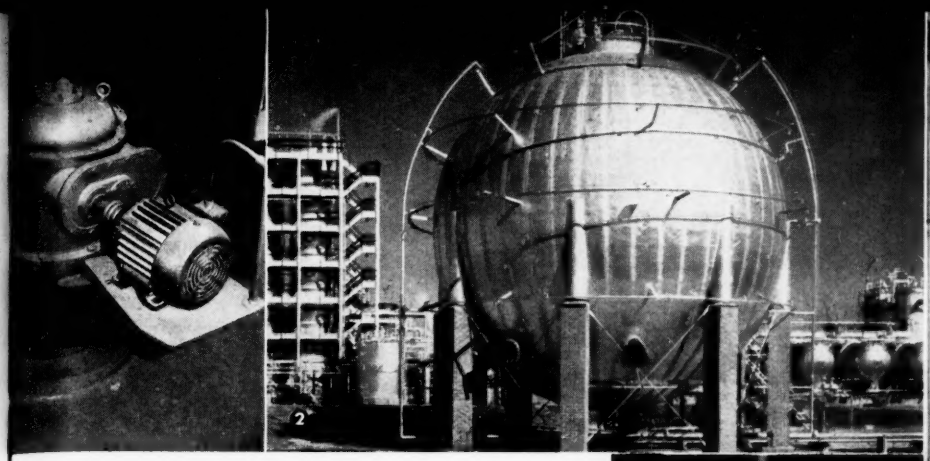
Basket-type device separates and dries without accumulation.

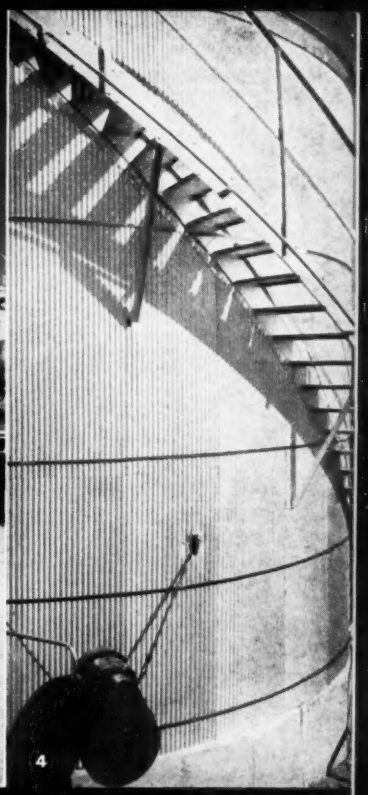
Displayed at the ACHEMA equipment show in Frankfurt, this filter continuously separates and dries a solid phase suspended in a liquid phase, without an accumulation of material in the device.

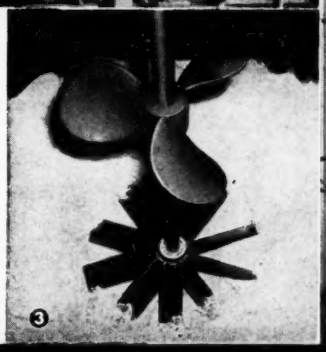
It consists of a perforated cone-shaped basket, which has a filtering medium mounted on its internal wall. Inside the basket, a spiral scraper rotates at a slightly different speed, carrying and regulating the movement of the solid product.

Mounted inside the slurry feed pipe, a separate pipe delivers wash liquor to a chamber of the rotating hub, from where it flows into various zones within the basket. Wash and mother liquors are collected and discharged separately, if desired.

Maximum diameter of the hori-







Ore purification in pressure vessel with Nettco tank top turbine mixer.

Butadiene blending with Nettco side drive mixers having replaceable, mechanical seals.

Violent agitation as produced by Nettco's unique combination of turbine and propeller drives.

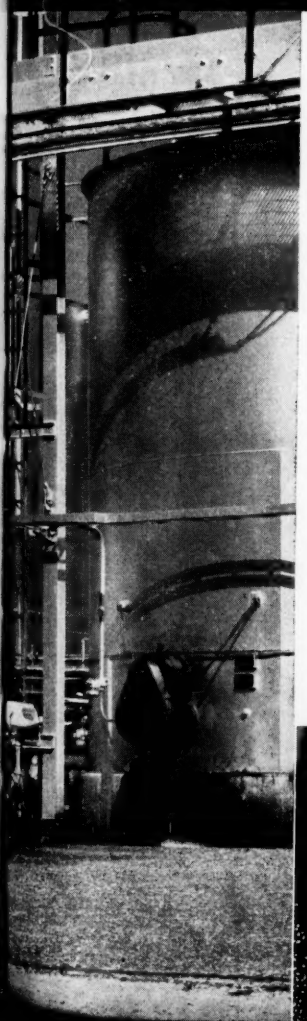
Maintaining product uniformity in Styrene storage tanks with Nettco side drive mixers.

Blending with Nettco side drive mixer in storage tank containing 20% caustic solution.

Small batch blending with versatile Nettco portable mixer.

Standardization of finished product with rugged Nettco vertical turbine mixers.

Improved Processing through Engineered Agitation



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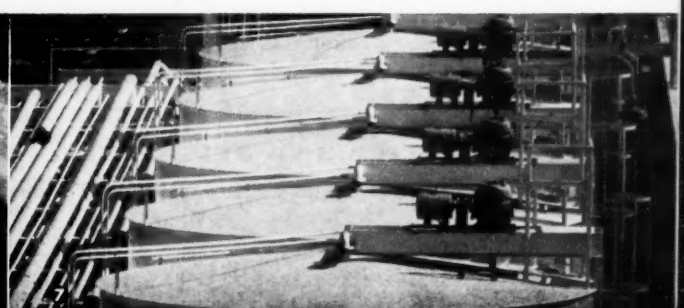
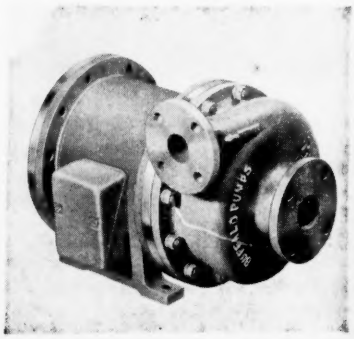


zontal centrifugals ranges from 10 to 23½-in. Drive motors provide from 10 to 40 hp. The units are particularly suitable for crystallized mineral products or organic synthetics.—**Ateliers Robatel et Mulatier, Lyon, France.** 192A



Sealless pump

Tapered bearings automatically adjust for wear, prolong life.

Volatile, expensive or noxious liquids are pumped by this hermetically sealed centrifugal pump that comes in 13 sizes with a capacity range of 5-800 gpm. Standard unit is designed for 120 psi. and 40-250 F.

The design includes self-adjusting, tapered bearings that automatically compensate for rotor or shaft wear. The bearings operate in and are lubricated by the fluid being pumped which, passing through an external or internal recirculation line, dissipates heat.

In the event of excess loads, thermo-protectors imbedded in the stator windings prevent the motor from burning out.—**Buffalo Pumps Div., Buffalo Forge Co., Buffalo, N. Y.** 194A

Briefs

Mercury floodlight, in 400, 700 and 1,000-w. sizes, has rated life of about 7,000 hr., has special air and moisture vent wick that keeps reflector and cover-glass surfaces free of condensation and dirt. It is said to deliver 2½ times more

light than a general-service filament lamp of the same wattage. — **Appleton Electric Co., Chicago.** 194B

Emergency light for hazardous locations will provide 25 w. of sealed-beam illumination for 5 hr. or more. Explosion proof and dust- and vaportight models are available. All have self-contained dry battery pack, and do not need a remotely mounted power supply. —**Carpenter Mfg. Co., Somerville, Mass.** 196A

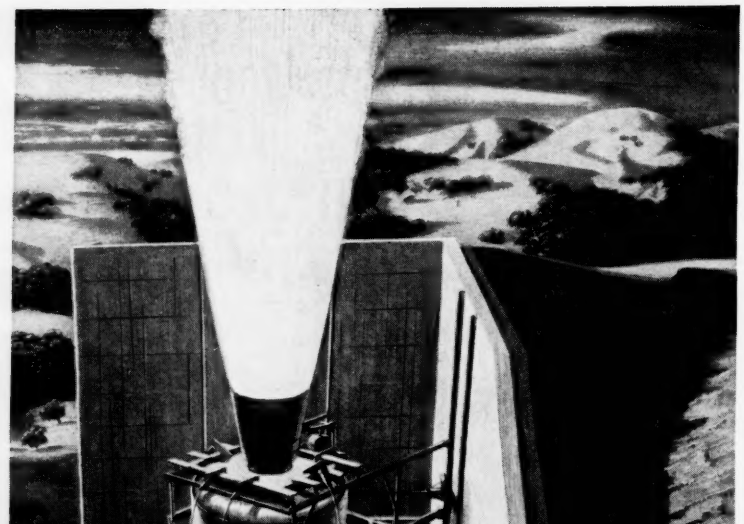
Transparent PVC tubing is available in regular and reinforced versions. Steel wire spring or braided nylon reinforcing are not exposed to either o.d. or i.d. of tubing, give it burst pressures up to 1,000 psi. — **Newage Industries, Inc., Jenkintown, Pa.** 196B

High-capacity pump for pressures to 200 psi. is driven by a helical gear reducer that accepts any of five gear ratios. Three pump sizes with 1,150 or 1,750-rpm. motor have a capacity range from 65 to 450 gpm.—**Viking Pump Co., Cedar Falls, Iowa.** 196C

Equipment Cost Indexes . . .

	Mar. 1961	June 1961
Industry		
Avg. of all	237.2	236.9
Process Industries		
Cement mfg.	231.3	230.9
Chemical	238.0	237.3
Clay products	224.8	224.4
Glass mfg.	224.7	224.0
Paint mfg.	229.7	229.4
Paper mfg.	229.3	228.6
Petroleum ind.	234.7	234.8
Petroleum ind.	234.7	234.8
Rubber ind.	237.6	237.6
Process ind. avg.	235.9	235.2
Related Industries		
Elec. Power equip.	237.9	235.1
Mining, milling	239.4	238.7
Refrigerating	268.5	268.6
Steam power	224.9	225.0

Compiled quarterly by Marshall and Stevens, Los Angeles, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; Mar. 6, 1961, pp. 115–116 for annual averages since 1913.



Left: Test-firing of large, flight-weight solid propellant rockets at UTC Development Center is important phase of multi-million pound thrust booster development program.

SOME OF THE AREAS IN WHICH MAJOR PROGRAMS CURRENTLY ARE BEING CARRIED FORWARD AT UTC

Chemistry and molecular physics of high polymer systems and fundamental mechanical properties of heterogeneous systems.

Theoretical propellant performance predictions and experimental determination of ballistic performance parameters of propellants.

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Optimization of solid propellant processing techniques and development of process methods for new propellants and motors.

Study of combustion of solid fuel and liquid oxidizer; establishing principles of injector design and grain configuration.

Investigation of design criteria for metallic and nonmetallic rocket cases, nozzles and component hardware.

Studies of heat transfer, thermodynamics and aerodynamics of rocket motors; stress analysis of structural design.

Positions currently available in these and other areas:

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Structures analyst
Reliability engineer
Polymer chemist
Plastics chemist

All qualified applicants will receive consideration for employment without regard to race, color, creed or national origin.

Technical Bookshelf

COVERS THE GAMUT

POLYMERIC MATERIALS. BY C. C. WINDING AND G. D. HIATT. MCGRAW-HILL. 406 PAGES. $12.

Reviewed by E. Farber, FMC Corp., Princeton, N. J.

The authors state that "this book is an introduction to the field of polymeric materials. Anyone starting work would normally specialize in a particular phase of the material covered in this book." Along these lines, this reviewer recommends this book not only for the polymer novice but also for the specialist who would like to have a well written text covering nearly all aspects of polymeric materials known to date. Even included are two of the newest commercial polymers—polycarbonates and polyoxymethylene.

Weakest part of the book is that dealing with "Solutions and Molecular Weights of High Polymers." In this chapter, several errors are apparent and it is likely that the authors are treading here on unfamiliar ground. This reviewer would also have liked to see more work presented on the stereospecific, e.g. Ziegler, type catalysts and polymerizations. However, considering the vast scope covered so adequately, these faults do not appear to be too glaring.

Presentation of the application and fabrication of polymeric materials is, although of a general nature, extremely well written and interesting. The breaking down of polymeric materials into chapters along generic lines, after general principles and properties have been reviewed, is very well done and the result is a clear and detailed understanding as to how and why these materials are used. Flowsheets for various polymerization processes are adequately presented.

In summary, the authors of "Polymeric Materials" have taken on the gigantic task of covering the gamut of polymer chemistry, engineering, and technology. That they have succeeded in doing so in a concise and lucid manner for the major portion of the book is much to their credit. "Polymeric Materials" is a text that should be a

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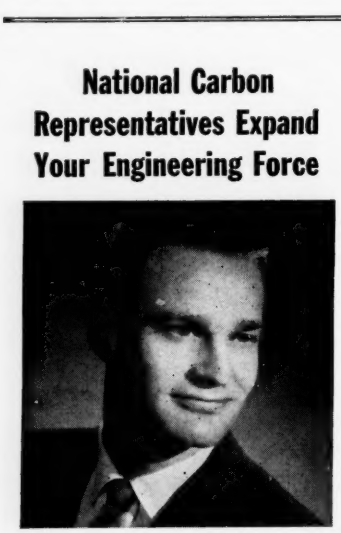
In Canada: Union Carbide Canada Limited, Toronto 12

National Carbon Representatives Expand Your Engineering Force



W. R. HEWITT
Sales Engineer

Mr. Hewitt joined National Carbon Company in 1955 as sales and service engineer handling the application of activated carbon to purification, separation, and recovery of gases and liquids.

Since 1960, he has been field engineer in the Pacific Northwest area for carbon, graphite, and "Karbate" impervious graphite products.

Mr Hewitt was graduated from M.I.T. with a B.S. degree in General Engineering.

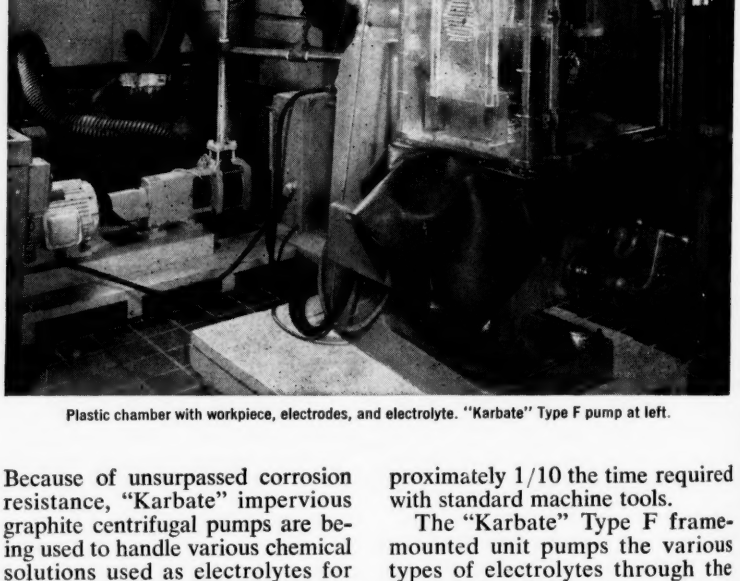
New Frame-mounted Models Expand "Karbate" Pump Line

The frame-mounted Type F pump expands to 32 the number of standard "Karbate" impervious graphite centrifugal pumps now available.

With discharge openings of 1½ and 2 inches, capacities to 140 gpm, and heads to 67 feet, this pump features the same wet end parts and mechanical seal used on "Karbate" motor-mounted models.

For detailed information on the features of "Karbate" centrifugal pumps, write for **Catalog Sections: S-7251, S-7253 and S-7254.**

Same "KARBATE" Pump Handles Wide Variety of Tough Corrosives



Plastic chamber with workpiece, electrodes, and electrolyte. "Karbate" Type F pump at left.

Because of unsurpassed corrosion resistance, "Karbate" impervious graphite centrifugal pumps are being used to handle various chemical solutions used as electrolytes for electroshaping intricate metal parts.

This electrochemical process, developed under sponsorship of Steel Improvement and Forge Company, Cleveland, permits the shaping of jet engine compressor blades in approximately 1/10 the time required with standard machine tools.

The "Karbate" Type F frame-mounted unit pumps the various types of electrolytes through the electrolytic cell. The pump operates at 3600 rpm, thus providing the high flow rate required past the electrodes to control temperature and maintain proper in-solution metal ion balance.

"Karbate" Pump Gives Trouble-free Service in 0° C. Application

An eastern chemical manufacturer has reported trouble-free operation of a "Karbate" impervious graphite Type F Model FBL centrifugal pump handling an acid solution of aluminum chloride at 0° C. In ten months of service only periodic seal adjustments have been required. The pump is equipped with the standard carbon-to-carbon rotary seal arrangement.

No other corrosion-resistant material can handle as wide a range of corrosives at temperatures from below zero to 340°F.

valuable addition to the libraries of both industry and the university.

And Also Received

Petro-Chem Guide to Europe. Jan. 1961. 66 pages. An invaluable reference guide to over 400 chemical, petroleum and petrochemical firms in 18 countries of Western Europe (including a separate listing of chemical and chemical engineering societies, institutes and universities). The complete, official, corporate names of all firms are given, along with the addresses of their headquarters and major plants (as well as their products). Each country is listed separately. Included is an index, as well as a table of conversion factors both for monetary exchange rates and physical measures. $12. Write: Noyes Development Corp., 38 E. 47th St., New York 22, N. Y.

Chem-Petro Guide: Canada and Latin America. May 1961. 65 pages. Companion piece to the above reference, this lists almost 500 chemical, petroleum and petrochemical firms in the Western Hemisphere (except for the U. S.). An expository section, called "Investment in Canada," painstakingly covers the types of Canadian organizations, and their income and other business taxes. Coming up in the windfall series of paperback, plastic-ring volumes: "Chem-Petro Guide: Asia," "Chem-Petro Guide: Africa," and "Chem-Petro Guide: Australia." $12.

A Summary of 1960 Annual Reports. 37 pages, including foldout table of abbreviated (for comparison) annual reports. Though published as a guide to its own investors by a New York investment house, this booklet is worth any CPI man's perusal. Annual reports of 41 of the biggest U. S. chemical firms are digested, scrutinized, and evaluated from the point of view of private investment. New products and current research are previewed. $2. Write: Mr. R. P. Windisch, W. E. Burnet & Co., 80 Pine St., New York 5, N. Y.

ASM Review of Metal Literature, 1960. Ed. by M. R. Hyslop. Almost 12,000 abstracts from the 1960

metallurgical literature, divided into 20 sections ("Ore and Raw Material Preparation," "Extraction and Refining," "Corrosion," "Powder Metallurgy," etc.). The 1,420-page volume is billed as "an annotated survey," is in fact a collation of the twelve 1960 issues of the ASM Review. Abstracts are stored in the computer memory of a GE-225 at the Center for Documentation and Communication Research at Western Reserve University, in Cleveland, which operates an information-retrieval program for ASM. $25. Write: American Society for Metals, Metals Park, Novelty, Ohio.

Proceedings of the International Symposium on Distillation held in Brighton, England, on May 4-6, 1960. Transcript of 34 papers and discussions (one of which is in French and another in German). Sample titles: "The Effects of Heat Transfer and Interfacial Tension in Distillation," "Frothing in Two-Component Liquid Mixtures," "Interstage Heat Transfer and Plate Performance in a Bubble-Cap Column," "Three-Component Distillation at Total Reflux: A Study Relating to Plate Efficiency." £ 4 ($11). Write: The Institution of Chemical Engineers, 16 Belgrave Square, London SW.1, England.

Metal Statistics 1960 with Buyer's Guide. This handy 832-page reference manual, almost every other page of which is an advertisement, tabulates figures on production, consumption, prices, imports and exports of metals and alloys from Al to Zn. Sources of the fat pocket-volume's data are not always quoted. In some cases, figures are given not for the metal but for its ore. Latest figures are for 1960. $3.50. Write: American Metal Market, 18 Cliff St., New York 38, N. Y.

Papers and Patents of Olin Mathieson Research Scientists, 1959. 533 pages. The collected texts of (1) 78 papers published by Olin researchers in 1959, and (2) 157 Olin patents printed in the 1959 *Official Gazette* of the U. S. Patent Office. Papers are grouped within five general headings: "Boron and Boron

metallurgical literature, divided into 20 sections ("Ore and Raw Material Preparation," "Extraction and Refining," "Corrosion," "Powder Metallurgy," etc.). The 1,420-page volume is billed as "an annotated survey," is in fact a collation of the twelve 1960 issues of the ASM Review. Abstracts are stored in the computer memory of a GE-225 at the Center for Documentation and Communication Research at Western Reserve University, in Cleveland, which operates an information-retrieval program for ASM. $25. Write: American Society for Metals, Metals Park, Novelty, Ohio.

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Compounds," "Cellulosic Materials, Polyolefins and Films," "Chemical Compounds and Processes Not Otherwise Classified," "Papers Not Otherwise Classified," and "Physiologically and Biologically Active Materials." Patent information rarely exceeds a paragraph, ranges in content from "Cigarette Filters" through "Boron Compounds" to "Firearms and Ammunition." For price, write: Audrey Dutoit, Olin Mathieson Chemical Corp., 460 Park Ave., New York 22.

Guide to Metallurgical Information. Ed. by E. W. Tapia. 85 pages. A list of metallurgical handbooks, bibliographies, dictionaries, encyclopedias, textbooks, periodicals, abstracting services, technical societies and their journals and other publications. More than 600 worldwide sources of metallurgical information are briefly described, with three different indexes steering the reader quickly to his answer. $4. Write: Special Libraries Assn., 31 E. 10th St., New York 3, N. Y.

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Technical Report Writing. 2nd ed. By F. H. Rhodes. McGraw-Hill. 168 pages. $5.50.

Reactor Handbook. 2nd ed. Vol. 2: Fuel Reprocessing. Ed. by S. M. Stoller and R. B. Richards. Interscience. 665 pages. $21.40.

Asphalt—Its Composition, Properties and Uses. By R. N. Traxler. Reinhold. 294 pages. $10.

Fuel Element Fabrication—With Special Emphasis on Cladding Materials. Vol. 2. By various authors. Academic Press. 384 pages. $10.

Management Models and Industrial Applications of Linear Programming. Vol. 1. By A. Charnes and W. W. Cooper. Wiley. 467 pages. $11.75.

The Optimal Design of Chemical Reactors. Vol. 3. By R. Aris. Academic Press. 191 pages. $7.

Writing a Technical Paper. By D. H. Menzel, H. M. Jones and L. G. Boyd. McGraw-Hill. 132 pages. $3.25.

Surface Activity and Detergency. Ed. by K. Durham. St. Martin's Press. 250 pages. $8.

Diazo and Azo Chemistry—Aliphatic and Aromatic Compounds. By H. Zollinger. Interscience. 444 pages. $16.10.

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18-19	39	61d	81	86D	102-103	165b	182B	191	199c	210C	214C	218C	222C	R235
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26-27	44	61g	82C	88C	109	168	185	193	200	211	215	218F	223B	237
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Manufacturers' Literature

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Chemicals

Acids and Anhydrides....48-page booklet describes properties and uses of organic acids and anhydrides and includes data on test methods, toxicological properties, etc.
210A Union Carbile Chemicals Co.

Activated Carbon.....A complete line of activated carbons for every purpose. Design and prefabricate complete purification, separation & recovery systems. Bul. J-103.
R234 *Barneby-Cheney

Adhesive.....Bulletins provide information and technical data on hot melt adhesive in cord-like form and lists materials which can be bonded.
210B United Shoe Machinery Corp.

Benzene.....Production has been increased to meet your rising needs. Capacity now exceeds 80 million gallons. Full facts on benzene are available on request.
93 *Shell Oil Company

Calcium Oxide.....Handbook "A Study of the Reaction Between Calcium Oxide and Water" covers hydration methods, heat distribution calculations and wet slaking methods.
210C National Gypsum Co.

Chemical Catalog.....46-page catalog of biochemicals includes rare sugars, amino acids and derivatives plus structural formulas, systematic names and prices.
210D Pfanstiehl Laboratories, Inc.

Furfural.....for new product or new process development. Additional information plus physical data on Furfural is contained in Bulletin 203-A which is offered.
45 *The Quaker Oats Co.

Hexachlorophene.....Bulletin "Methods of Analysis for the Quantitative Determination of G-11®" describes titrametric, colorimetric and ultraviolet determination procedures.
210E Sindar Corp.

Hydrogen Peroxide.....With this bleach, white materials are clear with no reversion and dyed shades are brighter and stay that way. Information.
85 *Becco Chemical Div.

Insulating Foam.....Dimensional stability, reduced cost and lower density are the outstanding features of a new urethane insulating foam described in booklet.
211A Nopco Chemical Co.

Methyl Chloride.....Storage, transfer and measurement of methyl chloride are covered in 14-page bulletin that applies equally well to other liquefied gases.
211B Ansul Chemical Co.

N-Butyl Alcohol.....12-page revised bulletin contains U.S.I. specifications in addition to resin solubilities and chemical references plus a list of binary and ternary azeotropes.
211C U. S. Industrial Chemicals Co.

Pseudocumene.....is now available for immediate delivery. A low-cost, highly reactive, aromatic hydrocarbon which can be readily converted to intermediates.
77 *Enjay Chemical Company

Plastic.....A bulletin, "The ABC's of Penton for Corrosion Resistance" rates Penton's performance at temperatures up to 250 deg. F. when exposed to over 300 chemicals.
90 *Hercules Powder Company

Plastic.....Seilon offers a complete line of corrosion resistant thermoplastic sheet materials . . . available in stock sheets 4' x 8' from 1/16" through 1" in thickness.
181 *Seiberling Rubber Co.

Resin Latex.....6-page brochure gives general information and data on properties, formulation and applications of new vinyl-acrylic copolymer despersion.
211D National Starch & Chemical Corp.

Synthetic Calcium.....MicroCel absorbs up to 6 times its weight in water. Available in several grades & offering a wide range of physical properties.
159 *Johns-Manville

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LITERATURE . . .

Urethane Foam.....Rigid urethane foam made with Hylene is easier to apply and has double the insulating capacity of ordinary insulation. Information is available.
111 *E. I. DuPont de Nemours

Construction Materials

Acid-Proof Cements.....Guide to the selection of the proper cement for corrosion proof installations lists more than 75 corrodent solutions and rates the various cements.
212A Acid-Proof Cement Mfg. Assn.

Alloys.....Two grades of Kennametal provide answers to difficult corrosion-wear application. A booklet, "Proven Uses of Kennametal" is available.
216 *Kennametal, Inc.

Aluminum.....A booklet entitled, "Process Industries Applications of Alcoa Aluminum" is available for information on the wide variety of applications of aluminum.
199d *Aluminum Co. of America

Aluminum.....Literature has been prepared to help in solving refinery corrosion problems through the use of aluminum and may be obtained upon request. No. 88-11453.
201b *Aluminum Co. of America

Aluminum.....A handbook is available which gives a wealth of information on aluminum alloy products. Includes conversion tables and specifications.
203 *Aluminum Co. of America

Aluminum Alloys.....A booklet giving information on resistance of aluminum alloys to weathering & to chemically contaminated atmospheres is available.
201a *Aluminum Co. of America

Gasket Materials.....24-page booklet AD-190 contains materials to aid user in the selection and specification of the proper gasket material.
212B Garlock, Inc.

Industrial Rubber Products.....for every need. Conveyor belts, flexible couplings, mountings, fenders, hose and packings and custom-designed products.
18-19 *U. S. Rubber Co.

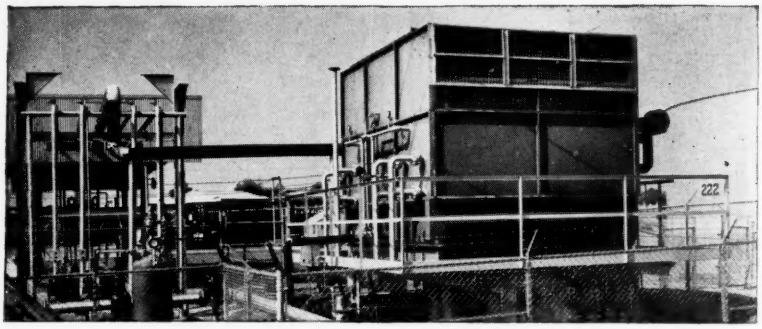
Insulating Cement.....Super "66" insulating cement for temperatures up to 1800 F. Can be applied on irregular shapes. Descriptive material is offered.
147 *The Eagle-Picher Co.

Insulation.....The new Industrial Insulation Catalog is offered. Also Data Sheets on the complete line of accessories for use with Foamglas insulation.
43 *Pittsburgh Corning Corp.

Packings.....Liquid-Pump packings handle all types of liquids; oil, water, chemicals, brine, etc., under many special operating conditions. Details.
94 *C. Lee Cook Co.

Packings.....Catalog presents line of molded packings for maintenance of presses, pumps, compressors and other hydraulic and pneumatic equipment plus data to aid in selection.
212C Green, Tweed & Co.

* From advertisement, this issue



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LITERATURE . . .

Protective Coatings. . . .Technical data are available on Amercoat No. 99 including a cost analysis showing savings you can realize with this coating.
163 *Amercoat Corp.

Protective Coating. . . . . Properties and application techniques for Lyykold Fibercoat, a weatherproof, mineral-armored asphalt, are described in 4-page bulletin.
214A American Bitumuls & Asphalt Co.

Silicone Rubber. . . . . Properties and applications of a wide range of silicone rubber products outlined in bulletin S901a with definitions and advantages included.
214B Hewitt-Robins

Stainless Steel. . . . . Armco 17-4 PH stainless steel offers excellent corrosion resistance. More specific information is available to help you cut costs.
170-171 *Armco Steel Corp.

Stainless Steel. . . . . Booklet "Producing Stainless Steels . . . Exclusively" is now available. It includes detailed sections on stainless steel plates, heads, etc.
36 *G. O. Carlson, Inc.

Synthetic Rubber. . . . Reference booklet "Industrial Report on Viton Synthetic Rubber" contains heat and fluid resistance data and also physical and resistance properties.
169 *E. I. du Pont de Nemours & Co.

Welding Aluminum. . . . . Literature is available giving detailed information welding aluminum in your various applications and may be had upon request.
199e *Aluminum Co. of America

Wire Cloth. . . . . Whatever metal or alloy needed in any size or quantity to the closest tolerances. High mesh mounts are featured. A catalog is available.
48 *Cambridge Wire Cloth Co.

Electrical & Mechanical

Cable Systems. . . .A booklet describes C-L-X (continuous lightweight exterior) metallic sheathed cable systems. Combines cable and duct in one integrated system.
214C Simplex Wire & Cable Co.

Couplings. . . . . Flexible cushion couplings that absorb vibration and compensate for all combinations of shaft misalignment and end float described in bulletin.
214D Dodge Mfg. Corp.

Gas Turbines. . . . . from 50 to 1100 hp, are designed specifically for industrial use. They are light weight, compact and lack vibration. Further information offered.
145 *Solar, Sub. of Internatl. Harv.

Hydraulic Accumulators. . . . . Reference manual includes missile age applications and recent developments plus history of accumulator development and details of operations.
214E Greer Hydraulics, Inc.

Mechanical Seal. . . . . Dura Seal will meet your sealing needs. Low in original cost with the least maintenance cost. Further details are offered in Catalog 480-CE.
R213 *Durametallic Corp.

* From advertisement, this issue

LITERATURE . . .

Mechanical Seals.....Chempro "wedge-lock" mechanical seals eliminate mounting gland. Bulletins CP-551 and 575 are available for further information.
L224 *Chemical & Power Products, Inc.

Motor.....TEIGF motor provides protection against expensive operation. Gas loss is lower than commercial standards. Further information is contained in Bul. 226.
157 *Electric Machinery Mfg. Co.

Motors.....4-page bulletin No. 107 describes shell-type motors available in open, enclosed or liquid cooled ratings ranging from ½ to 150 hp.
215A The Louis Allis Co.

Motors.....Crocker-Wheeler motors, from smallest to largest, are offered in all conventional enclosures and modifications with insulation to suit the application.
50 *Elliott Company

Panel Boards, Explosion-Proof.....A 28-page fully illustrated catalog, Bulletin 661 is available for complete information on these explosion-proof panel boards.
1 *Appleton Electric Co.

Pneumatics.....Catalog describes company's line of air-powered equipment, gives applications of materials dispensing equipment and includes selection guide.
215B Lincoln Engineering Co.

Power Recovery Turbine.....designed for power recovery from any gas mixture. Further information on any power recovery turbine application is available.
COV *Worthington Corp.

Handling & Packaging

Conveyors, Airstream.....A new 32-page brochure presents detailed information on how these conveyors solve bulk materials handling problems. Bulletin 530.
92 *Dracco, Div. of Fuller Co.

Feeders.....Rotary airlock feeders for use in handling problems of dust control and for pneumatic conveying. Bulletin P58 available upon request.
BR202 *Prater Pulverizer Company

Lift Truck.....A gas lift truck saves on initial price, saves on maintenance and saves on operating costs. With cushion rubber tires or pneumatic tires. Details.
95 *Automatic Transp. Co.

Materials Handling.....20-page catalog covers line of fork trucks, powered hand trucks, straddle carriers, towing tractors, attachments and container handling equipment.
215C Clark Equipment Co.

Pneumatic Conveying Systems.....All types of conveying systems are described in Bulletin M-588 which also tells how you can make substantial savings.
165a *The Day Company

Screw Elevator.....Rotor Lift screw elevators are compact with single leg design with low intake point. There are 8 basic types & 4 diameters. Engineering Catalog.
R221 *Southwestern Supply & Machine

* From advertisement, this issue

2 grades of KENNAMETAL* provide answers to difficult corrosion-wear applications

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Material	Loss in mg/dm²/day 22° centigrade 50% NaOH	5% H_2SO_4	37% HCl	Wear Resistance Factor	Combined Corrosion-Wear Resistance Factor
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K701 Kennametal	0.8	116	67	833	12
WC with 6% Cobalt	nil	123	163	203	7
Nickel	nil	39	3041	16	0.05
Ni-Cu Alloy	nil	40	2648	12	0.04
Co-Cr-W Cast Alloys	0.3	0.5	285	32	1

*Trademark

34229

INDUSTRY AND KENNAMETAL ...Partners in Progress

LITERATURE . . .

Vibratory Feeders.....Hi-Vi feeders move large tonnages of bulk materials with accurate control, more efficiently and economically. Details are found in bulletin.
216A *Eriez Mfg. Co.

Heating & Cooling

Air Systems.....An analysis of the need for, and the basic steps to follow in designing make-up air systems is discussed in an 8-page illustrated handbook.
216B Reznor Mfg. Co.

Coils, Smooth-Fin.....offer greater heat transfer per sq. ft. of face area and lower airway resistance—less power per c.f.m. Further details in Bul. S-55.
178 *Aerofin Corp.

Cooling Tower.....is completely free of structurals below the roof trusses. New Rigid-Bent design features tapered built-up columns outside the tower. Inform.
67 *Foster Wheeler Corp.

Drying & Cooling System.....Louisville fluidized bed equipment for use as dryers, coolers and reactors. Further information is contained in Bulletin FBD-61.
98 *General American Transportation

Electric Heating Units.....in laboratory, pilot or production packages 7KW to 300KW. Liquid phase up to 700 deg. F. Further information is available.
R197a *American Hydrotherm Corp.

Heat Exchangers.....Helpful information on the design and fabrication of heat exchangers and pressure vessels is contained in Bulletins HE and CI which are offered.
4 *Downington Iron Works, Inc.

Heat Exchangers & Condensers..... Literature has been prepared to show the advantages of using aluminimum for heat exchangers & condensers and is available on request.
205 *Aluminum Co. of America

Heat Exchangers, Liquid/Gas.....Units can be supplied in any alloy, any size, for any application. Additional information available on request.
187 *Marlo Coil Co.

Heat Transfer.....Platecoil saves on engineering, fabricating and installing in comparison with pipe coils. Greater heat transfer capacity permits compact units. Bul. P61.
34 *Platecoil Div., Tranter Mfg.

Kilns.....Thorough, experienced attention to engineering details produce kilns that are notable for continuous service. Further information in Bulletin 1115.
101 *Traylor Engrg. & Mfg. Co.

Oil & Gas Fired Heating Units.....with optimum temperature control. Packaged for indoor or outdoor use. Complete information on these units may be had upon request.
R197b *American Hydrotherm Corp.

Steam Generators.....in custom installations and package units. Bletin VF-VS-2 describes custom installation while Bulletin PSG-3 details package units.
112 *Henry Vogt Machine Co.

* From advertisement, this issue

LITERATURE . . .

Steam Reforming Furnace.....Technical details on the production of hydrogen & synthesis gas are contained in a paper, "What's New In Steam Methane Reforming."
81 *Selas Corp. of America

Steam Traps.....Type TD-50 can be used to control moisture content automatically. Other advantages include simplified piping, saved space, easy maintenance. Information.
173 *Sarco Company, Inc.

Temperature Control System.....Full information on new air controlled temperature and pressure control systems with cascade control accuracy is contained in Bul. 9.
71 *Spence Engineering Co., Inc.

Vapor Condenser.....The Aero vapor condensers are manufactured in standard units in a range of capacities up to thirty million BTU's. Bulletin 139-R.
TL213 *Niagara Blower Co.

Instruments & Controls

Alarm Indicating Monitor.....offers centralized monitoring of all important variables. The AIM is fast, reliable and compact. Further information is available.
89 *Hagan Chemicals & Controls

Analyzer.....can automatically analyze or monitor total amount of acid rather than pH condition. An abstract method kit and brochurre AKA are offered.
BL213 *Technicon Controls, Inc.

Computer.....G-15 is the leader among small and medium-scale computers. Features superior performance, real economy & proven support. Information is offered.
97 *Bendix Computer Div.

Control Instruments.....Pneumatic Consotrol instruments consistently deliver on all counts. The whole story on these instruments in Bulletins 13-18 & 13-19.
20-21 *Foxboro Company

Controls.....The complete design data on all sizes of standard flexible shafts, geared joints on terminals is contained in Design Manual 5811, is available.
196 *Stow Manufacturing Co.

Disc Indicators.....Bulletin describes disc indicator for strain gage transducer systems and includes specifications, and diagrams showing typical system applications.
217A Baldwin-Lima-Hamilton Corp.

Flow Ratio Control.....Four common forms of flow ratio control are consisely discussed and illustrated by simple schematic drawings in 4-page bulletin 91-10-01.
217B Fischer & Porter Co.

Industrial pH System.....The all-new Model J pH system is a compact transistorized analyzer with short, rugged electrodes & accessory mounting assemblies. File 14-36-06.
51 *Beckman Instruments, Inc.

Liquid Density Gauges.....New series of gauges providing continuous measurement of solution/slurry density without contacting material or moving parts is described in bulletin.
217C Nuclear-Chicago Corp.

* From advertisement, this issue

LITERATURE . . .

Recorder.....The new Universal Multipoint Electronik 15 recorder can record 2 to 24 points in a matter of seconds. Further details are available on request.
65 *Minneapolis-Honeywell

Telemetering System.....The Dynacode system is a new high-speed remote monitoring system based on Varec pulse code performance. Details in Bulletin 301.
75 *Dynel, Inc.

Test Instruments.....48-page condensed catalog describes instruments and systems used in the field of scientific measurement, recording and testing.
218A Minneapolis-Honeywell Co.

Transmitter.....The new Mag-Pipe flowmeter transmitter is fully transistorized for long-term reliability. Details are contained in Bulletin 98418.
14-15 *Taylor Instrument Companies

Pipe, Fittings & Valves

Aluminum Pipe & Fittings....A booklet describing aluminum pipe and fittings and their various applications and dimensions is available on request.
199a *Aluminum Co. of America

Arrestor Valve.....Bulletin describes surge arrestor valve with pilot controls that automatically open main valve on abnormal or subnormal pressure, or power failure.
218B Golden-Anderson Co.

Ball Valves.....Double-Seal ball valves are available in a wide variety of materials and sizes for many applications. Literature is offered.
35 *Jamesbury Corp.

Ball Valves.....The List 26 ball valve catalog describes this line in full. Includes technical data, suggested specifications, typical applications and installations.
218C Williamette Iron & Steel Co.

Cone Valves....manufactured to meet all critical flow and pressure conditions. Details are contained in Bulletin No. 2 which also contains a parts & materials list.
218D Williamette Iron & Steel Co.

Control Valves.....Catalog B-I is available for complete data on these versatile valves for positive control of your problem fluids.
TL221 *G. W. Dahl Co.

Control Valves.....Manual describes pneumatic diaphragm and piston actuators and a variety of valve body assemblies. 20-page section contains control valve selection information.
218E Fisher Governor Co.

Control Valve.....The new Series 1400 low flow control valve is available in a full range of materials, ratings and sizes. Complete details are in Bulletin B803-1.
79 *Minneapolis-Honeywell

Fittings.....Catalog shows available stock sizes and prices of ductile iron pipe fittings with ratings from 300 psi to 2000 psi and includes data on ductility, strength etc.
218F The Kuhns Bros. Co.

* From advertisement, this issue

LITERATURE . . .

Fittings & Flanges.....Detailed information on type and sizes of Orifice flanges and fittings available is contained in Bulletin TF-507.
104 *The Babcock & Wilcox Co.

Pipe, Pyrex.....comes in all standard sizes and fittings. You can see through the pipe wall into the flow area. Further information in Bulletin PE-3.
100 *Corning Glass Works

Pipe, Rubber.....Condor flexible rubber pipe outlasts steel 3 to 10 times. Installation is easy, economical and there is no danger of leaky joints at pipe bends. Bul. 7152.
96 *Raybestos-Manhattan, Inc.

Pipe Product.....A technical report on Duotrace, a product which contains two trace passages & a product passage integrally extruded in a single pipe is offered.
199c *Aluminum Co. of America

Pipe & Tube.....Technical and specification data are contained in a booklet showing how epoxy pipe and tube solves tough corrosion, temperature & pressure problems.
219A Fibercast Co.

Piping & Tracing.....A bulletin describing Unitrace which combines piping and tracing in one unit is offered and may be had upon request.
199b *Aluminum Co. of America

Piping Products.....Fluoroflex-T piping can handle the most difficult materials up to 500 F. They are resistant to most chemicals. Information.
8-9 *Resistoflex Corp.

Spray Nozzles.....A comprehensive spray nozzle catalog is available. Contains complete, accurate performance data for each of the hundreds of nozzles in the line.
166 *Spray Engineering Co.

Spray Nozzles.....Catalog 24 is the most comprehensive catalog ever printed. Spray nozzles are completely described and the catalog is fully illustrated.
TR202 *Spraying Systems Co.

Studding Outlets.....feature compact design and built-in reinforcement. A general catalog is available which gives details on these outlets and other products.
B222 *Lenape Hydraulic Press. & Forg.

Tube Expanders.....New tube expanders roll tubes into thick sheets in one pass. Bul. Y-52 outlines the complete line of retubing accessories plus tube expanders.
174 *Elliott Co.

Unions.....have the hardness differential which assures fast, easy make-up, tight seal & freedom from galling. Four different seat types. Facts are offered.
190 *Rockwood Sprinkler Co.

Valve Manifolds.....RegO safety relief valve manifolds cost far less to buy, far less to maintain. Pop-action design keeps product loss to a minimum.
39 *The Bastian-Blessing Company

Valves.....New 8", 10" and 12" Teflon-sleeved, non-lubricated plug valves are now available. Also available in bottom-entry. 3-way design & choice of metals.
59 *Continental Mfg. Co.

* From advertisement, this issue

LITERATURE . . .

Valves.....Eccentric-Action, Non-Lubricated valves mean no more leakage losses and no more greasing or oiling. Details are contained in Control Bulletin 150.
204 *DeZurik Corp.

Valves.....for fast, easy opening and closing with a leak-proof seal & straight-through flow with minimum pressure drop. Informative bulletin is available.
49 *Everlasting Valve Co.

Valves.....Brochure contains report on features of cast steel and fabricated pipeline gate valves, general pipeline and manifolding service valves and regular port valves.
220A Grove Valve & Regulator Co.

Valves.....Forged steel valves are available on all lines up to 2 in. Designed to meet control requirements with minimum replacement & maintenance. Information.
99 *Ohio Injector Co.

Valves.....Type N body seat with molded Teflon FEP resin provides friction-free seating and has 400 deg. F. maximum temperature rating. Catalog 61-B.
155 *Orbit Valve Co.

Valves.....Corrosion-resistant Rovalves for the paper, chemical & petroleum industries are described in Catalog 425-A. Specifications & prices included.
220B W. G. Rovang & Associates

Valves, Ball.....in a full range of pipe sizes from ⅜" to 14". A wide range of design variations including metal castings of stainless steel, carbon steel, etc.
191 *Rockwood Sprinkler Co.

Valves, Butterfly.....Double R/L butterfly valves offer dependable bubble-tight shutoff. This valve has many other features described in Bulletin 91.
BR206 *Continental Equipment Co.

Valves, Stainless Steel.....New catalog covers valves in the patterns you want, in a choice of alloys that satisfy the requirements of practically all corrosive services.
91 *Jenkins Bros.

Process Equipment

Centrifugal.....The new Model HS 40 W pressure centrifugal features completely and readily accessible interior. Complete specifications are available.
47 *Baker, Perkins, Inc.

Centrifugal Separator.....assembled as a package unit. To process slurries difficult to dewater. Details are contained in Brochure 961 which is available.
BL221 *Heyl & Patterson, Inc.

Centrifugals.....The Roberts LS/SC provides a combination of features. No metal to metal moving parts, rigid feed, wash, effluent, and solids-discharge connections.
210 *The Western States Machine Co.

Classifiers.....can be operated in series to obtain several closely sized fractions in one continuous operation. Further information is available.
L236 *Buell Engineering Co.

* From advertisement, this issue

Converters.....Chemical & Plastic converters are available in a variety of sizes. Complete information on all models is available on request.
T222 *Mitts & Merrill

Crusher.....Bulletin 6020 describes crusher designed for fine reduction of wet and sticky clays or shale without the inherent problems of plugging and caking.
222A Pennsylvania Crusher Div.

Dryer.....Unique agitator design improves heat transfer coefficient, speeds mixing of materials & discharge rate. Dryer Bulletin 302 is available on request.
R235 *Bethlehem Fdry. & Machine

Dryer.....Rotary Steam Tube Dryers engineered to dry 264,000 lbs. per day, are described in Catalog A. Also covers pressing, drying and cooling problems.
TR206 *Davenport Machine & Fdry. Co.

Dryer.....Fluid-Flo dryer gives you continuous, automatic processing with minimum product loss and degradation. Details are contained in Folder 2909.
33 *Link-Belt Co.

Dryer, Vacuum Rotary....designed for efficient removal of moisture at low temperatures is described in detail in the booklet which is available on request.
212 *Goslin-Birmingham Mfg. Co.

Dryers.....Oriad Desiccant dryers offer complete reactivation, perfect temperature control, and full automatic operation. Further details in Bulletin D-103.
73 *The C. M. Kemp Mfg. Co.

Drying Equipment....Kathabar equipment for toasting, drying or cooling. Complete data is available on request for further information on these systems.
223 *Surface Combustion

Dust Filter.....Bulletin details the design and construction, and pictures installations of filter; includes dimensions and specifications of single and multiple units.
222B The Day Co.

Ejectors.....Standard ejectors are available in sizes up to 3-in. maximum section for fast delivery. They are simple, dependable and low-cost vacuum-producing devices.
R220 *Elliott Company

Feeder.....Merchen feeder gives you greater feeding accuracy because of its sensitivity. It is compact & gives you hour-to-hour accuracy for feeding & blending. Inform.
182 *Wallace & Tiernan, Inc.

Magnetic Separators.....to protect your machinery, production and reputation against dangerous tramp iron. Full data are contained in new bulletin which is offered.
222C *Eriez Mfg. Co.

Mixers.....A full line of side drive, tank top, portable or tripod and continuous pipeline mixers for your mixing needs. Additional information in Bulletin 582.
193 *Nettco Corporation

Mixers.....Dispersator mixers with the patented "Micro-Shear" head feature: double shearing, balanced operation at much higher speeds than conventional mixers, etc.
TL197 *Premier Mill Corp.

LITERATURE . . .

Molecular Sieves.....offer important savings achieved by increasing throughput of existing equipment. Designed for low-maintenance cyclic processing. Details.
215 *Linde Co., Div. of Union Carbide

Molecular Vacuum Still.....for distilling material with a high molecular weight and contaminated by color, odor or other impurities. Information on request.
172 *Consolidated Vacuum Corp.

Mulling.....Simpson Mix-Muller is specifically designed to put you in control of mixed properties. The Handbook on Mulling is available on request.
109 *National Engineering Co.

Process Centrifuges.....perform separations of types and efficiencies not previously possible. A booklet on centrifuge types and their applications is available.
16-17 *De Laval Separator Co.

Process Equipment.....Mixing, cooking or cooling equipment plus vacuum pans, coils, coating pans, filters, tubular heat exchangers, etc. are covered in Engineering Manual.
L235 *Groen Mfg. Co.

Process Equipment.....such as dryers, coolers, combination ammoniator-granulators, furnaces, cookers, reactors, presses and pilot plants. Literature is offered.
180 *Edw. Renneburg & Sons

Processing Equipment.....A 32-page report on impervious graphite processing equipment covers 16 different types of equipment. Includes sizes, dimensions & costs.
83 *Falls Industries, Inc.

Processor.....The Holo-Flite is a simpler, more compact way to cool, heat or dry—in a continuous flow. An 8-pg. bulletin describes its features & applications.
BL197 *Western Precipitation Corp.

Roller Mills.....Pulverizer catalog covers line of screen type and pneumatic roller mills for semi-fine and fine grinding of nonmetallic minerals.
223A Bradley Pulverizer Co.

Rotary Blenders.....are available in 9 standard models with capacities to 900 cu. ft. Feature self-cleaning dust-sealed drum. Bulletin 080B for more information.
R224a *Sturtevant Mill Co.

Scrubbers.....S-F Venturi scrubbers for air pollution control and for solids recovery from kiln gases. Has no nozzles, trays or jets to plug. Information.
29 *Chemical Construction Corp.

Vacuum Tumble Dryers.....Catalog 16-P contains complete technical information on vacuum tumble dryers, Twin-Shell blenders and the new solids-processor.
56-57 *Patterson-Kelley

Vibratory Screens.....Bulletin illustrates true balanced-mass design and point-of-no-oscillation suspension and describes screen's positive, self-adjusting eccentric drive.
223B Comco Corp.

Water Process Equipment.....A new Catalog #160 on Water Demineralizers and Catalog "G" on Stills and accessories for pure water are available on request.
194 *Barnstead Still & Sterilizer Co.

* From advertisement, this issue

LITERATURE . . .

Pumps, Fans & Compressors

Acid Pump, Steam Jacketed.....guarantees trouble-free, low cost pumping of solutions which thicken or solidify above ambient temperatures. Details are available.
237 *A. R. Wilfley & Sons, Inc.

Blowers.....for metered, oil-free air and gas handling. Series 3200 for large capacity air requirements. Further information is contained in Bulletin S-59-I.
L202 *Sutorbilt Corp.

Centrifugal Fans.....RD fans can provide pressures up to 4.5 psi and capacities up to 600,000 cfm. Further information and duty areas in Bulletin 3449-11.
22-23 *Joy Manufacturing Co.

Centrifugal Pumps.....Close-coupled end-suction centrifugal pumps described and illustrated in bulletin that includes selection chart, dimensions, limitations chart etc.
224A The Aurora Pump Div.

Metering Pump.....Pulsafeeder metering pump offers precision metering at flow rates of from a few drops to 15.7 gal. per minute. Complete details in Catalog 59.
167 *Lapp Insulator Co.

Metering Pump.....New Metriflow metering pump with duplex units provide twice the capacity with one motor. Complete information is available on request.
T225 *Madden Corp.

Pump.....Series 100 pump features accurate metering with smooth control plus double capacity or two-liquid metering. Further information is available.
183 *Wallace & Tiernan, Inc.

Pumps.....for hard-to-handle liquids in the chemical industry. Pumps range from 25 to 2500 hp., pressures to 50,000 psi. Additional information is available.
32 *Aldrich Pump Company

Pumps.....New Can-O-Matic pumps with self-adjusting bearings are leak-proof. Information and specifications are contained in Advance Bulletin 977 which is offered.
28 *Buffalo Forge Co., Pumps Div.

Pumps.....Controlled capacity pumps for continuous, accurate metering of all types of liquids. Features exclusive liquid-end design. Information offered.
176 *Clark-Cooper Div.

Pumps.....satisfy virtually all pumping requirements and feature higher speeds, non-overloading head-capacity stability.
179 *Johnson Pump Co.

Pumps.....A larger range of helical gear driven units to fit your pumping needs is now available. Detailed information is contained in Catalog SP-534C.
192 *Viking Pump Company

Pumps.....End suction centrifugal pumps are offered in 350 series for chemical & 300 series for general process services. A 12-page catalog is available.
175 *C. H. Wheeler & Co.

* From advertisement, this issue

LITERATURE . . .

Pumps, Centrifugal.....to solve your processing problem. All the models and useful engineering data are included in Bulletin 130 which is available on request.
130 *Eastern Industries, Inc.

Pumps, Glassed.....Full details on this glassed pump is contained in Bulletin 725.2 which is offered along with booklet, "It's What's Inside That Counts."
44 *Goulds Pumps, Inc.

Rotary Pump.....for corrosion problem liquids or semi-liquids. All 316 stainless steel heavy duty construction. Catalog P-333 is available for further information.
185 *Waukesha Foundry Co.

Vacuum Pumps.....32-page catalog gives complete data on rotary positive air pressure and high vacuum pumps, gas boosters and air motors and includes engineering data.
225A Leiman Bros.

Vacuum Pump.....designed for compactness with no costly extras to buy. Further information is available on this line along with a Vacuum Slide calculator.
L234 *F. J. Stokes Corp.

Services & Miscellaneous

Casters & Wheels.....All types of rubber treads for smooth operation on all kinds of floors. A new manual is offered describing nearly 4,000 types.
L220 *Darnell Corp.

Cost Engineering.....Detailed information on the subject of cost engineering is contained in Booklet E-3 which is available on request.
236 *Western Supply Co.

Developments Review.....Detailed and informative 36-page booklet "Engineering in Action" reviews companies progress in research, power generation, defense, etc.
225B Allis Chalmers Mfg. Co.

Fire-Fighting Products.....Foam liquid binds large volumes of air & water into an effective low cost extinguishing agent for fighting any type of fire. Illustrated booklet.
153 Rockwood Sprinkler Co.

Hydrants.....B-50-B hydrants are built for exceptional service. Available in types & sizes for practically every installation. Bulletin 5710 is available for details.
46 *Darling Valve & Mfg. Co.

Hydraulic Puller.....handles hundreds of pushing, pulling and pressing jobs quickly and safely. Full details are contained in new literature.
211 *Snap-On Tools

Knife Cutter.....engineered for tough size reduction jobs with superior results. Their application and versatility are practically unlimited. Bulletin 213.
168 *Sprout, Waldron & Co., Inc.

Tower Cleaning.....Literature and details on any cleaning problem-towers, tanks, pumps, compressors, exchangers, lines, fittings, valves and other equipment.
218 *Oakite Products, Inc.

*From advertisement, this issue

EMPLOYMENT OPPORTUNITIES

(Continued on following page)

ADDRESS BOX NO. REPLIES TO: Box No.
Classified Adv. Div. of this publication.
Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 645 N. Michigan Ave.
SAN FRANCISCO 11: 255 California St.

POSITION VACANT

Purchasing Agent—Growing midwest processing company has opening for neat, bright, energetic, graduate engineer about 30 years old. Must have some processing experience. Purchasing experience desirable but not essential. Send resume of education, experience, and salary history to P-7263, Chemical Engineering.

EMPLOYMENT SERVICES

Better Positions—$6,000 to $50,000. Want a substantial salary increase, more opportunity or different location? This national 50 year old service connects you with best openings. You pay us only nominal fee for negotiations; this we refund when employer pays placement fee. Present position protected. In complete confidence. Write for particulars, R. W. Bixby, Inc., 653 Brisbane Bldg., Buffalo 3, N. Y.

POSITIONS WANTED

Operations or engineering management. B.Ch.E., 1940. Inorganic and organic experience. Const-conscious and progressive. Prefer South or East. PW-7261, Chemical Engineering.

BSME—Ga. Tech 55—Age 27—married, 5 years experience: Plant Engineering, and Mechanical Design, Plant startup and production supervision process development. Speak fluent Spanish. Seek responsible permanent position. PW-7273, Chemical Engineering.

Equipment Searchlight

CE's Searchlight spots the big bargains in used, resale and rental equipment. Check this issue's listings—most complete in the field—for items you need now.

▶ **Coverage** — National Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

▶ **Rates**—$21.75 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

▶ **Closing Date**—October 2nd issue closes September 8th. Send all new ads to Chemical Engineering, Classified Adv. Division, P. O. Box 12, New York 36, N. Y.

LIQUIDATIONS

CLEVELAND, OHIO

1—Raymond #73612 Super High Side 6-Roll Mill, with whizzer, cyclone, piping and motors.

1—Raymond # 6669 Super High Side 6-Roll Mill, with whizzer, cyclone, piping and motors.

1—Raymond #5047 High Side 4-Roll Mill, with whizzer, cyclone and piping

1—#1 Raymond Impact Mill, with whizzer, cyclone and piping.

2—Sturtevant 14′ dia. Air Separators.

1—Kilby Nickel Single Effect Force Feed Evaporators, 1200 sq. ft.
2—12,000 gal. Nickel Clad Tanks.
2—Oliver 5′3″x4′ Nickel Clad Rotary Vacuum Filters.
2—Pfaudler 300 and 200 gal. Glass Lined Jkt. Agt. Reactors.
1—Sperry 30″ C.I. Filter Press, 27 chambers.
1—Buflovak 32″x90″ Dble Drum Dryer.
4—Feinc 8′x12′ Rotary Vacuum Steel Filters, string discharge.
2—Peabody Gas Scrubbers stainless steel 11,000 CFM and 6,000 CFM at 145°F with fans, motors.
2—6′6″ dia. x 60′ Rotary Dryers.
1—5½′x4½′x50′ Rotary Dryer.
1—5½′x4½′x60′ Rotary Dryer.
7—Dorr 80′ and 40′ thickeners.
3—Vogt 387 sq. ft. Rotary Press. Filters.
2—Chicago Pneumatic 26″x14″ Vacuum Pumps with 150 HP motors.
3—Fuller Kinyon Pumps H5 and H6.
1—Link-Belt 24″x90′ Belt Conveyor
5—Nickel Centrif. Pumps, 2″, 3″.

GENEVA, NEW YORK

2—Vulcan 3′x20′ 347 S.S. Packed Columns with 240 sq. ft. S.S. Heat Exchanger.
5—S.S. Condensers 70 to 250 sq. ft.
6—Nash H5, L5 Vac. Pumps 20 & 15 HP.
1—Nash L3 Stainless Vacuum Pump.
6—1,200, 1,000 & 400 gal. 347 S.S. tanks
8—25,000 gal. Aluminum Storage Tanks, ½″ shell.
2—3000 gal. Aluminum Tanks, 7′x11′.
1—Tolhurst 40″ Centrifuge 347 S.S. imperforate basket, 15 HP.
1—Swenson Vert. 347 S.S. Single Effect Evap. 300 sq. ft.
2—Banks S.S. cooling coils, each bank having 24—2″ tubes 20′ long.

BRILL FOR VALUES

CENTRIFUGES

3—Bird 18″ x 28″, 24″ x 38″ Solid Bowl Continuous 304 S.S.
1—Bird 40″ x 60″ Solid Bowl Continuous 316 S.S. UNUSED.
5—Sharples C-20 and C-27 Super-D-Hydrator 316 S.S.
3—Sharples PY 14, PN14 Super-D-Canters 316 S.S.
2—Sharples #16, 304 S.S., 3 HP motor.
1—Tolhurst 40″ 347 S.S. imperforate basket 15 HP UNUSED.

TANKS

25—500 to 3500 gal. Vertical 304 S.S. Tanks opened and closed, some agitated.
6—7500, 6000 and 2000 gal. Rubber Lined Tanks.
1—1500 gal. Stainless Pressure Tank, 5′ x 10′, 90#.
1—2000 gal. Horizontal 304 S.S. Tank 5′ x 12′.
1—2500 gal. Vertical 304 S.S. Tank 8′ x 7′.
1—10,000 gal. Rubber Lined Tank 10′ x 17′6″.
1—5500 gal. 316 S.S. Clad Pressure Tank 250 PSI.
1—12,000 gal. Horizontal Steel Pressure Tank 7′6″ x 36′, 200 PSI.
5—25,000 gal. Aluminum Storage Tanks.

REACTORS—EVAPS—CONDS—COLUMNS

1—Pfaudler 125 gal. 304 S.S. Jacketed Agitated Reactor 150# int., 125# jacket.
3—Pfaudler 200 gal. glass lined jacketed Kettles.
2—Pfaudler 50 gal. glass lined, Jacketed, Agitated Reactors.
1—650 gal. 304 S.S. Reactor with 100 sq. ft. Bayonet Heater.
1—O. G. Kelly 3000 sq. ft. 309 S.S. force feed Evaporator UNUSED.
1—550 sq. ft. Buflovak monel single effect Evaporator.
1—250 sq. ft. Buflovak 304 S.S. Single Effect Evaporator.
10—Stainless Heat Exchangers; 910, 536, 370, 250, 131, 70 sq. ft.
1—4′6″ x 46′ 316 S.S. Clad Column, 250 PSI.
6—30″ x 19′ S.S. Packed Columns.
1—24″ x 35′ 304 S.S. Bubble Cap Column.

FILTERS

2—Niagara 110 sq. ft. Vert. 316 S.S.
1—Niagara 92 sq. ft. Vert. Jkt. 316 S.S.
2—#10 Sweetland, 27 leaves 4″ centers
1—#5 Sweetland 304 S.S., 120 sq. ft.
1—Oliver 6′ dia. Horizontal 316 S.S.
1—Oliver 4′ dia. Monel Horizontal.
1—U.S. 200 sq. ft. 304 S.S. Auto-Jet.
1—Hercules 400 sq. ft. 304 S.S. Pressure.
3—Oliver Precoat 5′ x 6′, 5′ x 10′, 8′ x 10′.
1—Oliver 5′3″ x 8′ Steel Rotary Vac housing.
1—Feinc 3′ x 1′ 316 S.S. Rotary Vac.

DRYERS

1—Buflovak Vacuum Shelf, 17—60″ x 80″ shelves.
2—Buflovak 42″ x 120″, atmospheric double drum complete.
1—Buflovak 32″ x 90″ Atmos. Twin Drum.
2—Devine 4′ x 9′ single drum, atmospheric.
1—Buflovak 3′ x 10′ Rotary Vacuum.
6—Louisville Rotary Steam Tube 5′ x 6′, 6′ x 30′, 6′ x 50′.
2—Louisville 8′ x 50′ Stainless Steel lined Rotary.
3—Rotary Dryers 4′ x 40′, 6′ x 50′, 6′ x 60′, 7′ x 80′, 8′ x 87′.
1—Louisville 4½′ x 25′ Inconel Rotary.
1—Link Belt 6′4″ x 24′ Roto Louvre 316 S.S.
2—Atmos. Tray, 16 shelves, 40″x24″.
2—10′ and 4′ dia. 304 S.S. Spray Dryers.
2—Wyssmont, 304 S.S. 6′2″ and 9′6″ dia.

MIXERS

1—Sturtevant 75 cu. ft. 304 S.S. Rotary Batch Blender 20 HP.
1—Abbe 110 gal. 304 S.S. Jacketed Agitated Vacuum Dispersall Mixer.
2—Day Imperial 150 gal. jktd. double arm.
2—Baker Perkins 150 and 100 gal. jacketed double arm Sigma blades.
1—Baker Perkins 50 gal. jacketed.
5—Day "Cincinnatus" double arm, 250 and 100 gal.
2—Steel jacketed Powder Mixers, 225 and 350 cu. ft.
1—1500# Powder Mixer 304 S.S.
1—3′ dia. Simpson Intensive Mixer.
1—45″ dia. Lancaster Mixer 7½ HP motor.

MISCELLANEOUS

3—Kinney Vacuum Pumps, 1000 cfm, 10 microns, 15 HP.
2—Hardinge 5′ x 22″ steel lined conical Ball Mills.
3—Mikro Pulverizers, 1SH, 1SI and Bantam.
3—Abbe 2½″ x 3′ porcelain lined Pebble Mill XP motor.
1—Raymond 10″ vert. Mill, 10 HP.
3—Swenson Walker Continuous Crystallizers, 24″ x 30′ sections.
2—#24 Rotex Sifters 20″ x 64″, 40″ x 56″.
5—Day Roball Sifters, 40″ x 120″, 40″ x 84″, Double Deck.
6—Nash H6, H5, H3 Vacuum Pumps.
3—Nash H6, 347 S.S. Vacuum Pumps.
2—Stokes Rotary Tablet Machines DD2-DDS2.

Partial List of Values—Send for Complete Circular

BRILL EQUIPMENT COMPANY

35-61 JABEZ ST., NEWARK 5, N. J. Tel: MArket 3-7420—N. Y. Tel: RE 2-0820
TEXAS OFFICE: 4101 San Jacinto St., Houston 4, Texas—Tel: JAckson 6-1351

CIRCLE K ON READER SERVICE CARD

MULTI-MILLION DOLLAR
LIQUIDATION
NORTH LITTLE ROCK, ARK.

STAINLESS STEEL TANKS

13,300 gal., 11'10"x15'7", cone top.
12,000 gal., 11'6" x 15'6", cone top.
3650 gal., 10' x 7', open top.
3000 gal., 5' x 19', T347SS, ASME 60 psi, dished heads.
1350 gal., 4'x14', T347SS, ASME 60 psi, dished heads, int. coils.
1300 gal., 7' x 4'6", T321SS, closed
1100 gal., 4' x 11', T347SS, ASME 60 psi, 3/16" shell, ¼" heads.
476 gal., 4'6" x 4', open top.
475 gal., 5'6"x2'6", open top.
445 gal., 6'x2', open top.
300 gal., 4'x3', T347SS, ASME 60 psi, dished heads.
285 gal., 41"x49", open top.
260 gal., 40"x48", closed top.

GLASS-LINED TANKS

Pfaudler 11,500 gal. horiz. blue glass-lined tanks, 8' x 30', ½" shell, 7/16" dished heads, 20 psi. With 75 sq. ft. nickel coil, Aurora St. St. sump pump.

STEEL PRESSURE TANKS

28,000 gal. 11' x 38', dished, ASME 75 psi.
28,000 gal. 11' x 38', lead-lined.
14,000 gal., 8' x 36', dished.
11,000 gal., 8' x 27', dished, ASME 300 psi.
9000 gal., 8' x 23', dished.
5200 gal., 6' x 24', dished, 60 psi.
3300 gal., 6' x 15-6", dished, ASME 125 psi.

BOILERS

3—3000 CFM Edgemoor waste-heat boilers, 250 psi, 535 sq.ft., ASME.
5—435 HP Comb. Eng. water-tube boilers, 300 psi, 4620 sq. ft., 34,500 lb. steam/hr. @ 225% of rating, gas or oil fired.

COMPRESSORS—BLOWERS

Worth 3500 CFM air comp., 24 x 15, #LTC-4, 500 HP gas driven.
Chicago-Pneu. 3026 CFM air comp., size #19-32-30-18 x 24, horiz. steam driven.
Elliott turbo-blowers, 11,620 CFM, type 0, 15.9 psi discharge, 125 HP.
Ing.-Rand 6 x 6 x 5 air comp., V-type, 2 cyl, #67D9, type 30.

SEND FOR DETAILED CIRCULAR

KETTLES—REACTORS

1400 gal. Pfaudler blue glass-lined jacketed kettles, 84" dia. x 54" high, open top, Stainless Steel cover, 3 HP Agit., Adj. baffle.
1250 gal. Pfaudler blue glass-lined jkt. reactors (Sulphonators), 72" dia. x 72" high, closed, 3 HP Agit.
600 gal. Plaudler Stainless Steel ammoniating & crystallizing jkt. kettles, 60" dia. x 46" high, open.
250 gal. Plaudler blue glass-lined jacketed kettles, 42" dia. x 36" high, open top, Stainless Steel cover.

STAINLESS PUMPS

Worthington Worthite Cent. Pumps; 4" x 3", 3" x 2", 2" x 1½", 1½" x 1", w/motors.
LaBour 2" 316 SS self-priming cent. pumps w/motors.

COLUMNS—HEAT EXCHANGERS

24" dia. x 15' high Duriron packed columns, 1" cast sections.
24" dia. x 33' high Duriron & St. St. packed column.
1450 sq. ft. T347SS gas condensers, 3-pass Vert. units.
1000 sq. ft. Duriron pipe coolers.
564 sq. ft. Stainless Steel burner-Preheaters, gas condensers, 3-pass.
400 sq. ft. Stainless Steel open-pipe coolers, 2⅜" OD pipe.
Amer. spiral heat exchangers T316L S/S: 162, 72 sq. ft.
Duriron pipe coolers, 159, 130, 125, 99, 54, 44, 42, 10 sq. ft.

STAINLESS PIPE—VALVES

Vapor pipe—6" to 20" dia. pipe—sch. 10 & 40, 1" to 6" dia. valves—flanged, gate, globe, etc.

PERRY
EQUIPMENT CORP.
1413-21 N. SIXTH ST.
PHILADELPHIA 22, PA.
Phone POplar 3-3505

CIRCLE L ON READER SERVICE CARD

Baker Perk. 15 HP. Masticator Mixer.
Hersey 5'x26' Rotary Dryer, 316 S.S.
Day Hy—R Speed Mill 20 HP Expl. Pr.
Buffalo 32"x90" Double Drum Dryer.
Centrifugals: 12", 30", 40" & 48".
Centrifuges: Sharples #5 & #6 Stainless.
Dryers:
Buffalo Vac. Drum Dryer, 24"x20".
Gehnrich Elec. Htd. Dryer 7'x3'x6'.
Despatch Ovens Elec. Heated & others.
3—Devine & Stokes Vac. Shelf Dryers.
Filters: #2 Sweetland 12 Stainless Leaves.
Niagara S.S. Leaf Filter 45.5 sq. ft.
Oliver Rot. Vac. 3'x1'.
Hercules Leaf Filter 36" diam.
Filter Presses: 6" to 36" Iron & Wood.
Kettles, Tanks: S.S. Jack 20 to 1000 gal.
Dopp 350 gal. cast iron Jack. Vacuum.
Devine Impreg. Units 30" to 36" dia.
Mills: Raymond #00, 3 HP, & #0000.
Mikro Pulverizers #4, 2, 1, & Bantam.
Hammer Mills & Pulverizers 3 to 50 HP.
Rotary Cutters 1½ to 5 HP & up.
Spr. Waldron Stainless spike crusher.
Pebble, Jar & Ball Mills, Lab. to 6' x 8'.
3 Roll, 9" x 32", 12" x 30", 16" x 40".
Lehman 4 Roll W.C. 12' x 36" Steel.
Colloid Mills 1½ H.P. & up.
Mixers: BP & Day 5, 50, 75, 100 & 150 gal.
Change Can Mixers 8, 15, 40, 150 gal.
Sprout-Wald., 10,000# horiz. Spiral Mixer.
Day Jumbo 700 gal. horiz. mixer.
Spiral Mixers, 3000, 1000# etc.
Lancaster 6' dia. 25 HP.
Pumps: Stokes etc. Vac. 10 to 500 CFM.
Gould 75 HP, Centrifugal 250 PSI.
Sifters: Day, Robinson, Rotex type.
Tablet Machines: Stokes R. Colton 4½ T, single punch, Stokes RDI Rotary etc.
Hydr. Presses, Plastic & Rubber Machy.
Partial Listings. Write For Bulletins

STEIN EQUIPT. CO.
107-8th St., Brooklyn 15, N. Y. Sterling 8-1944

CIRCLE M ON READER SERVICE CARD

NEW FILTER, stainless steel NIAGARA 48" dia. w/510 sq. ft.

NEW GRANULATOR #24, Stokes oscillating, S/S, also used 43A, S/S

NEW VOTATOR, S/S, lab. model, 4 speed

FURNACE, electric, 5"X12"X30" muffle, 1600°C, Globar, w/50KVA transformer

MIKRO PULVERIZERS, 2 model 2TH w/ 10HP motors & vari-drive feeds

OVEN, Truck/Tray, 650° F. electric, 5'X6'6"X14', self-contained package unit.

LAWLER COMPANY
Durham Ave. Liberty 9-0245 Metuchen, N. J.

CIRCLE N ON READER SERVICE CARD

BOILERS
HI-PRESSURE
turbogenerators, pumps, fans,
Nation's largest inventory. New & Used
INDECK POWER EQUIPMENT CO.
9750 Skokie Blvd., Chicago (Skokie) Ill. OR 3-7666

CIRCLE O ON READER SERVICE CARD

YOUR $ BUYS MORE

STAINLESS SIGMA MIXER

Baker Perkins Size 14 working capacity 50 gallons. Heavy cored sigma blades, code jacket for 125 PSI. Vacuum cover. Gearhead motor drive. New 1956. Excellent condition. Stainless construction throughout.

Inspect In Our Stock

ME MACHINERY AND EQUIPMENT CO., INC.
123 Townsend St. · San Francisco 7, Calif.

CIRCLE P ON READER SERVICE CARD

IT COSTS LESS at M&E

2—Bird 18" x 28" horizontal cont. Centrifuges. Steel cont

1—Oliver 3' x 6' all rubber rotary cont Vac Filter. Variable speed drive

1—Simpson #2 Mixmuller 6' dia Pan. Comp w/15 HP Motor. Double Mullers

2—Cedar Rapids 30" x 38" slugger type Hammermills. 150 HP late style GE Mtr

1—Kue-Ken Mod 90 Jaw Crusher 36" x 20". 70/160 TPH

1—Eppenback 30 gal SS Agi Mixer. Vac cover. Agit Jcktd w/Homo Mixer. Comp

2—Rotary Flame Dryers, 6' dia 35' long. ½" shell. Fully equipped

1—New Kelly SS Evaporator. 3000 sq ft 750-1" OD 12 ga tubes 15' long

MACHINERY AND EQUIPMENT CO., INC.
123 TOWNSEND ST. · SAN FRANCISCO 7, CALIFORNIA

CIRCLE R ON READER SERVICE CARD

LOCOMOTIVES—RR CARS & CRANES
9 Gen. Elec. 20, 25, 45, 65, 70, 80, 100, 125 Ton
25-Ton Industrial Brownhoist 60' Boom Crane
200—50 Ton Box 300—70 Ton Gondola Cars
300—1½, 5, 20 & 30 yd Dump Cars

PLANT EQUIPMENT
2—Wemco 2M-HMS Plants
No. 1 Sturtevant Hammer Bar Mill
No. 2 Robins Vertical Cone Crusher
24" x 24" Jeffrey Single Roll Crusher
No. 1 Sturtevant Rotary Fine Reduction Crusher
F55 Syntron Grizzley Feeder
5' x 8' & 4½' x 9' KVS Air Swept Ball Type Mills
Bail Mills: No. 56, 5' x 5', 6' x 4', & 7' x 22'
Hardinge Mills: 3' x 8', 5' x 22" & 8' x 22"
Rod Mills: 4' x 11', 6' x 12' & 7' x 15'
Jaw Crushers: 8" x 10", 9" x 24", 10" x 30", 12" x 26", 13" x 24", 14" x 28", 18" x 36", 30" x 36", 66" x 84"
Crushers, Fine Reduction: 22", 2', 3', 4', 5½' & 7'
636 & 436 Allis Chalmers Hydrocone Crushers
Crushers Roll: 14" x 14", 30" x 14", 40" x 16"
Rotary Dryers: 5' x 30', 6' x 50', 6' x 70' & 8' x 80'
Rotary Kilns: 6' x 70', 7' x 110' & 9' x 160'
2—13" x 120" Buflovak Atmos Double Drum Dryer
Roto Louvre #207-10 Type 316 S.S. Link Belt
150—1½, 2 & 4 yd & 30 yd Dump Cars
5 & 10 HP LB Car Pullers
3'x 12' Seco Single Deck Vibrating Screen
16' Gayco Centrifugal Air Separators
BX-100 Sutton Steele & Steele Air Table NEW
6—30" x 32" Dings Magnetic Head Pulleys
690', 2200', 3068' & 3600-7500' I.R. Compressors
4100 CFM Sly Dust Collector

WANT BUY DRYERS—KILNS—CRUSHERS

R. C. Stanhope, Inc., 60 E. 42 St., N.Y. 17, N.Y.
Tel. MU 2-3075 or MU 2-1898

CIRCLE Z ON READER SERVICE CARD

FOR SALE

2—Heating votators, girdler, cylinder size 10" x 62" vertical SS-T-304 complete with 50 hp motors.

1—Cooling votator, girdler, cylinder size 24" x 72" aluminum blades, nickel chrome heat transfer tubes, all other parts in contact with product 304 SS complete with drive and 40 hp motors.

1—Kemp carbon dioxide removal unit, 6000 SCFH inert gas capacity.

3—Homogenizers, Tri Homo 16" hi torque, SS T 316, with "V" belt drive, new condition.

Misc. pumps, motors, drives,—tanks

Complete surplus list available upon request.

THE CHEMSTRAND CORP.
DECATUR, ALA.
Attn: C. G. Hudson

CIRCLE S ON READER SERVICE CARD

BOILERS

TURBO-GENERATORS • DIESELS
PUMPS • FANS • BURNERS • HEATERS

Large Selection . . . New and Used

EXPERIENCED ENGINEERS TO ASSIST YOU

WABASH POWER •EXPORT•

WABASH
POWER EQUIPMENT CO.
PHONE IN 3-0303
3300 W. PATTERSON AVE.
CHICAGO 45, ILL.

CIRCLE V ON READER SERVICE CARD

BEST VALUES

Vacuum Dryer: Stokes 2' x 6' Rotary, jacketed, st.st. With drive, condenser, receiver.
Evaporator: Buflovak dbl. eff. st.st. 608 sq. ft.
Evaporator: Buflovak dbl. eff. st.st. 845 sq. ft.
Evaporator: Mojonnier dbl. eff. st.st. 1250 sq. ft.
Dryers: Double Drum, 42 x 90; 32 x 100 Buflovak.
Dryer: Double Drum, 42 x 120 American.
Heat Exchangers: (2)—1900 sq. ft. admiralty tubes, steel bodies, ASME.
Twin Shell Blender, Patterson-Kelly, 30 cu. ft. S.S. T304. 7½ H.P. drive.
Centrifuges: Tolhurst 40" and 26" Suspended, perf.
Centrifuges: Bird continuous, 18 x 28, S.S. T316.
Filter, Rotary Vacuum with pressure housing, Dorr Oliver 5'3" dia. x 4' face (2).
Tanks: 2300 (2) gal.—1500 gal., vertical St.St.
Tanks: 3000 (2) gal.—1500—900 gal., vertical St.St. for vacuum with coils.
Kettles: (2) 600 gal. agitated st.st.; with 15 P.S.I. steel jacket.

BEST EQUIPMENT COMPANY
1737 W. HOWARD ST. CHICAGO 26, ILL.
AMbassador 2-1452.

CIRCLE AA ON READER SERVICE CARD

SEPTEMBER SPECIALS

Stokes vac. 2 shelf dryer 40" x 42" with pump
Gruendler #3 Hammermill, Whirlbeater, 22"
Pfaudler 1500 gal. glass lined Tank, closed top
Ribbon Blenders, Steel & SS, all sizes, new & Used
Day #40 Imperial jkt. 300 gal. Mixer 40 HP
Simpson 24" Lab. SS Mix Muller, 1½ HP motor
Day 75 gal. sigma arm Mixer wth 7½ HP motor
2 Fitz Mills Model D, 5 HP motors
Abbe 5'x6' jktd. Ball Mill, chrome mang. steel

WHAT HAVE YOU FOR SALE OR TRADE?
YOU CAN BANK ON

EQUIPMENT CLEARING HOUSE, INC.
111 33 Street, Brooklyn 32, N. Y.
SOuth 8-4451—4452—8782

CIRCLE W ON READER SERVICE CARD

OVER 5,000 MACHINES IN STOCK

FOR EVERY INDUSTRY AND PURPOSE

- Wrappers
- Packaging machines
- Cartoning machines
- Fillers
- Labelers
- Filter presses
- Roller mills
- Mixers
- Pulverizers
- Grinders
- Dryers
- Sifters
- Cappers
- Tablet machines

TELL US YOUR REQUIREMENTS

Complete Details And Our Special Low Bargain Prices Available On Request

UNION STANDARD EQUIPMENT CO.
318-322 Lafayette St., New York 12, N. Y.
Phone: Canal 6-5333-4-5-6

CIRCLE BB ON READER SERVICE CARD

SPECIALS

Kettles: 60 gal. st. steel agit. ASME.
Mill: Day Hispeed Model B 14x30" 3-Roll.
Column: 24" x 22', 316 stain, steel.
Pebble Mills: Abbe #3, #6, and others.
Dryer: American 24x48" dbl. drum.
Dryer: Bowen lab. spray, st. st.
Evaporator: Buflovak sgl. eff. st. st. 94 sq. ft.
Dryer: Porter 2 x 4' vac. drum., st. st.
Centrigugal: Tolhurst 26" rubber, 2-speed.
Filter: Sweetland #5 st. st. lined.
Filter: Oliver precoat 12x2" type 316 st. st.
Vacuum Pans: 42" and 72" stain. steel.
Dryer: Proctor & Schwartz 6-tray st. st.
Centrifugal: AT & M 60" st. st. perf.

Write us or call Seeley 8-1431
Send us a list of your idle machines

LOEB EQUIPMENT SUPPLY CO.
820 W. Superior St., Chicago 22, Ill.

CIRCLE T ON READER SERVICE CARD

Screener 2 Deck S.S., also steel

S.S. Jacketed—Blender—Double Ribbon —240 cu. ft.—total

Reactors 500 gal—750 gal steel

Baker Perkins—100 gal—50 HP, S.S. 2 arm jacketed-vacuum hdr. tilt

Aluminum Evaporator Calandria type—never used—1300 sq ft. tube area

Hydraulic Pumps & motors.

MACHINECRAFT CORPORATION
800 Wilson Ave. (East of Doremus)
Newark 5, N. J. MI 2-7634

CIRCLE X ON READER SERVICE CARD

OUTSTANDING VALUES!

400 gal SS jktd and agit reactor.
40" rubber lined centrifuge.
Stokes 8 shelf vac dryer.
P K Twinshell blender 40 cu. ft.

CHEMICAL & PROCESS MACHINERY CORP.
50-52 9th St., Brooklyn 15, N. Y. HY-9-7200

CIRCLE CC ON READER SERVICE CARD

RAYMOND FLASH DRYING SYSTEM
Complete—Unused
LINK BELT ROTO LOUVRE DRYERS, 6'x24'
316 S/S
SPRAY DRYERS S/S. PRODUCTION & LAB.
SEND US YOUR INQUIRIES
N. J. SNOW EQUIPMENT CO.
1700 Holcombe Houston 25, Texas JA 2-0359
507 Fifth Ave. New York City OX 7-5895

CIRCLE U ON READER SERVICE CARD

2—New 5000 Gallon Pressure Vessels

Mfgd. by Babcock & Wilcox. ASME rated, 1750# oper. press.; 3572# press. tested. 650 deg. F max. temp.; Weight 80,500# Blt. 1952. Size 23' L x 53" I.D. With piping, valves, fittings, etc.

Pressure pumps—all sizes and kinds available.

EVEREADY—Box 1780—Bridgeport, Conn.
Ed McCallum ED. 4-9471

CIRCLE Y ON READER SERVICE CARD

IX PLANT AND DRYER FOR SALE

Complete Fully Automatic Ion Exchange Plant. Capacity 100,000 U.S. gallons per day containing 3.75 grams per litre U_3O_8. Bartlett and Snow 8' Steam Dryer. Condition excellent. Surplus due completion government contract.

RAYROCK MINES LIMITED
DISCOVERY, N.W.T. CANADA

CIRCLE DD ON READER SERVICE CARD

FACE the future with profit in mind!

USE GELB CHEMICAL PROCESS EQUIPMENT

4—Sharples type 316 SS nozljectors with 40 HP explosion proof motors.
1—Bird SS 40" suspended type centrifuge complete with perforate basket, plow and motor.
3—Dover 2000 gal. steel jacketed reactor.
1—Rietz SS pilot plant grinder.

AUTOCLAVES, KETTLES, REACTORS

1—Glascote Series HR 1000 gal. glass lined jacketed reactor, complete with impeller type agitator, baffle and drive
1—Pfaudler 750 gal. glass lined jacketed reactor
2—Pfaudler Series EM 300 gal. glass lined jacketed reactors'
1—300 gal. Hastelloy "B" jacketed pressure reactor
1—Blaw Knox 300 gal. stainless steel vacuum reactor
2—Theo. Walters Hastelloy "B" 300 gal. jacketed reactors
4—Pfaudler Series P glass lined jacketed reactors, complete with agitators and drives, 5, 20 and 30 gal.
1—Van Alst 300 gal. stainless steel jacketed kettle
2—Blaw Knox steel autoclaves, 600 gal.
1—Alloy Fabricators steel jacketed autoclave, 600 gal.
1—125 gal. stainless steel jacketed autoclave with impeller type agitator and drive, 125 psi jacket, 75 psi internal
2—Stainless steel 2000 gal. horizontal storage tanks
1—Patterson-Kelley stainless steel jacketed 1000 gal. reactor
1—Glascote 750 gal. glass lined jacketed vacuum receiver

CENTRIFUGES

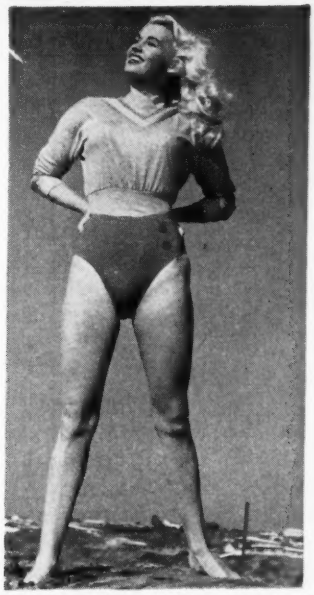
1—Tolhurst type 316 stainless steel 48" Batch-O-Matic centrifuge, NEW
1—Fletcher 48" stainless steel underdriven centrifuge, complete
1—AT&M 26" type 316 SS suspended type centrifuge, complete
5—Tolhurst 40" and 30" rubber covered centrifuges
1—Sharples type 316 SS Super-D-Canter, PN-14, complete
1—Sharples type 316 SS centrifuge, Model D-2
1—Sharples Super-D-Hydrator, monel, Model C-27

DRYERS

2—Louisville 8' x 50' stainless steel rotary dryers
1—Buflovak 24" x 36 chrome plated double drum dryer
1—Allis Chalmers stainless steel rotary dryer, 6' x 50'
10—Allis Chalmers rotary dryers, 6' x 50' and 7' x 60'
1—Buflovak stainless steel jacketed rotary vacuum dryer, 5' x 30'
1—Link Belt steel roto louvre dryer, Model 207-10
1—Link Belt steel roto louvre dryer, Model 502-20
1—American 42" x 120" double drum dryer, ASME, complete
1—Buflovak steel jacketed rotary dryer, 3' x 15'
2—Stainless steel pilot plant spray dryers

FILTERS

2—Oliver stainless steel rotary filters, 3' x 2' and 3' x 4'
12—Sweetland #12 pressure leaf filters with 72 stainless steel leaves
1—Niagara stainless steel filter, Model 510-28
1—Sperry 36" x 36" heresite covered filter press, 40 chambers
10—Shriver plate and frame filter presses, 12" to 42"



THE GELB GIRL—SEPTEMBER 1961

MIXERS

1—Abbe 10 gal. steel double arm sigma blade jacketed mixer
1—J. H. Day 200 gal. stainless steel double arm sigma blade jacketed mixer
3—Sprout Waldron 30 cu. ft. jacketed double ribbon blenders, steel
1—Gemco stainless steel double cone jacketed blender, 69 cu. ft.
1—Stokes stainless steel granulator, Model 43B
1—Sturtevant #7 dustite rotary batch blender, NEW
15—Robinson type 304 SS horizontal blenders, 255 cu. ft.
1—Robinson type 304 SS horizontal blender, 125 cu. ft.
1—Baker Perkins 150 gal. dispersion type mixer, complete
1—J. H. Day 5 gal. double arm sigma blade mixer, stainless steel
1—Stokes stainless steel granulating mixer, Model 21-J
1—Patterson-Kelley stainless steel twin shell blender, 2 cu. ft.

MISCELLANEOUS

1—Cleaver Brooks 500 HP package steam generator, 200#
1—Cleaver Brooks 150 HP package steam generator, 150 psi
1—Superior 300 HP package, steam generator, 125 psi
1—Sprout Waldron pelletizer, Type 501FF
1—Williams "Comet" 4 roll mill, complete
1—Raymond 2 roll high side mill
1—6" x 14" Ross 3 roll paint mill, high speed, complete
1—Vulcan stainless steel bubble cap column, 4' dia. x 25 plates
1—Griscom Russell stainless steel heat exchanger, 900 sq. ft.
3—Badger stainless steel heat exchangers, 500 sq. ft. and 600 sq. ft.
4—Patterson stainless steel condensers, 200 and 300 sq. ft.
20—Davis Engineering stainless steel heat exchangers, 102, 119, 136, 166 sq. ft., NEW
1—Pfaudler glass lined thimble condenser, 62 sq. ft.
3—Pfaudler glass lined thimble type condensers, 9 and 14 sq. ft.
1—Struthers Wells stainless steel 1150 sq. ft. single effect evaporator
2—Mikro #3TH stainless steel pulverizers, complete
2—Mikro Bantam pulverizers

1—Pfaudler Series R 1500 gal. glass lined jacketed reactor complete with agitator and drive.
3—Mikro #3TH stainless steel pulverizers.
150—Worthington and Durimet 20 centrifugal pumps, all sizes
3—Western States type 316 SS 40" suspended type centrifuges complete with perforate baskets, plows and motors.

R. GELB & SONS, INC.
U. S. HIGHWAY 22, UNION, N. J. · MURDOCK 6-4900
75 ANNIVERSARY

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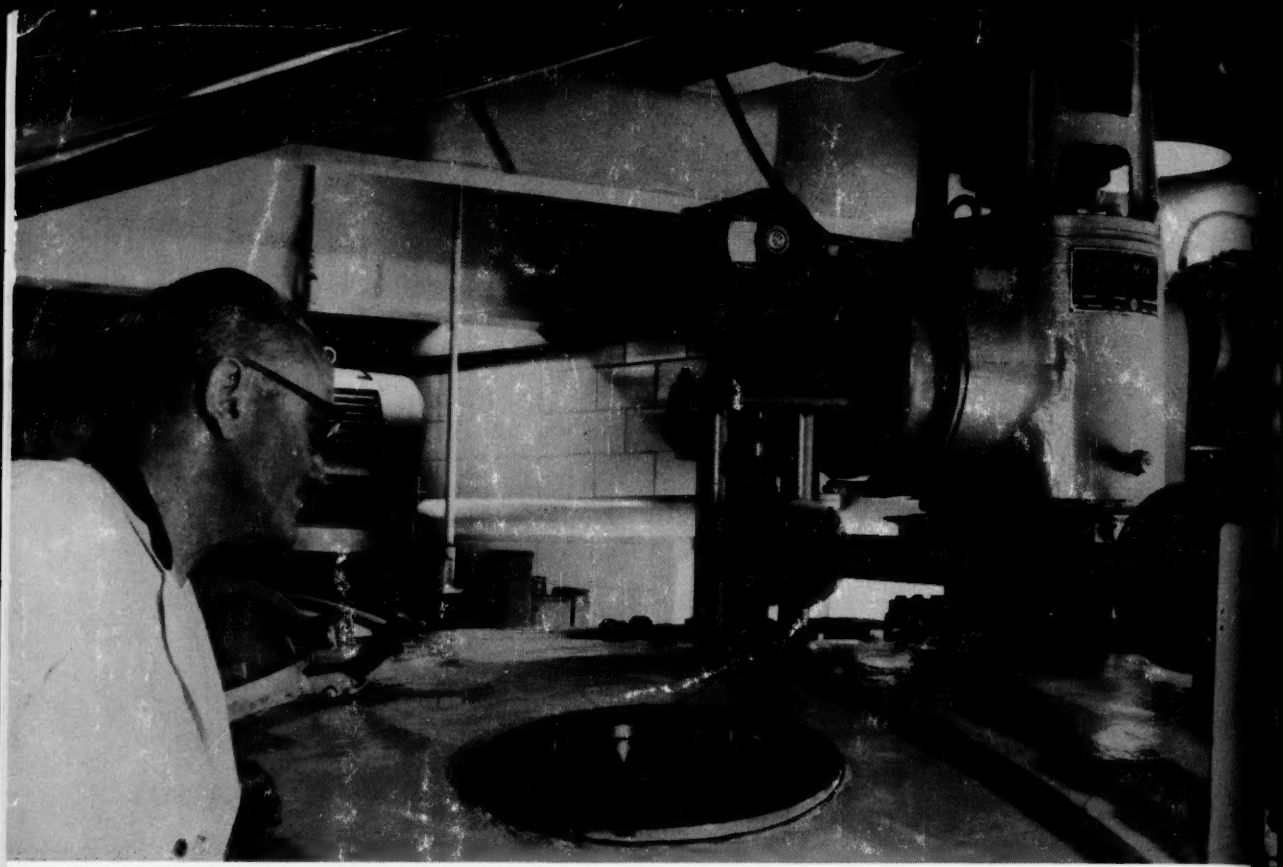

Hiram Walker & Sons Limited, Walkerville, Ontario

Canadian Club begins with good mixing

This big yeast tank is Step One in a process that develops and protects the unique qualities of Canadian Club whisky.

In six tanks like this one, the yeast incubates 24 hours in a medium of sterilized malt, rye, and water under conditions of surgical cleanliness and strictly monitored temperature.

A turbine-type LIGHTNIN Mixer keeps the culture medium in constant, even flow to insure uniform temperature throughout each of the big jacketed tanks.

Slurrying, cooking

While yeast propagates, another LIGHTNIN Mixer rapidly slurries barley malt in water, suspending the fine grains in a homogeneous, lump-free mixture that permits close control of available enzyme content.

Concurrently, 12 more LIGHTNIN Mixers mounted on four cereal cookers keep heat uniform as live steam cooks grain starch to a mash. Mixing continues at constant speed despite an extreme jump in viscosity as the hot mash is flash-cooled.

Reacting, fermenting

Next, cooled mash and malt slurry meet in converter tanks where LIGHTNIN Mixers assist the starch-enzyme reaction by holding ingredients in a uniform dispersion.

Finally, maltose-rich mash is mixed with the 24-hour-old yeast in conical-bottom fermenter vessels. After fermentation the fermented mash is pumped to beer wells where bottom-mounted propeller-type LIGHTNIN Mixers keep the insoluble grain particles in complete and uniform suspension. From beer wells the mash is fed continuously to distilling columns.

What user says

"LIGHTNIN Mixers are selected throughout our plant," declares Frank D. Leeder, superintendent of manufacturing and maturing at this Hiram Walker distillery, "because they meet our requirements for trouble-free service, performance, and sanitary maintenance—and, of equal importance, the service we receive when we have a problem. MIXCO makes their machines work. Our experience with LIGHTNIN Mixers has firmed our belief that no one knows more about mixing than the people at MIXCO."

For fluid mixing that does what you want it to do—at lowest long-term cost—call in your LIGHTNIN Mixer representative. His name is in Thomas' Register and in the yellow pages of your telephone book. Or write directly to us.

"Lightnin Mixers"

MIXCO fluid mixing specialists

MIXING EQUIPMENT Co., Inc., 128-j Mt. Read Blvd., Rochester 3, N.Y.

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